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ISOLATED PLANT FOR WEBSTER BUILDING

Economical Operation of Isolated Power Plant for Production of Heat, Light and Power in Chicago Loop

ONE OF THE MOST perplexing questions confronting power consumers at the present time is that of deciding on the best economical means for obtaining their required light, heat and power. The 2 main points under discussion are, the purchase of the necessary light and power from a large central station or the installation of an isolated plant.

In the recently completed 12-story Webster office building on La Salle St., Chicago, Ill., a newly equipped isolated plant is in operation, furnishing light, heat and power, not only for its own requirements but also supplying several other buildings in the immediate vicinity. The economical operation of the old plant in the original building, no doubt, convincingly proved the advisability of a new and strictly up-to-date plant in the new structure. This

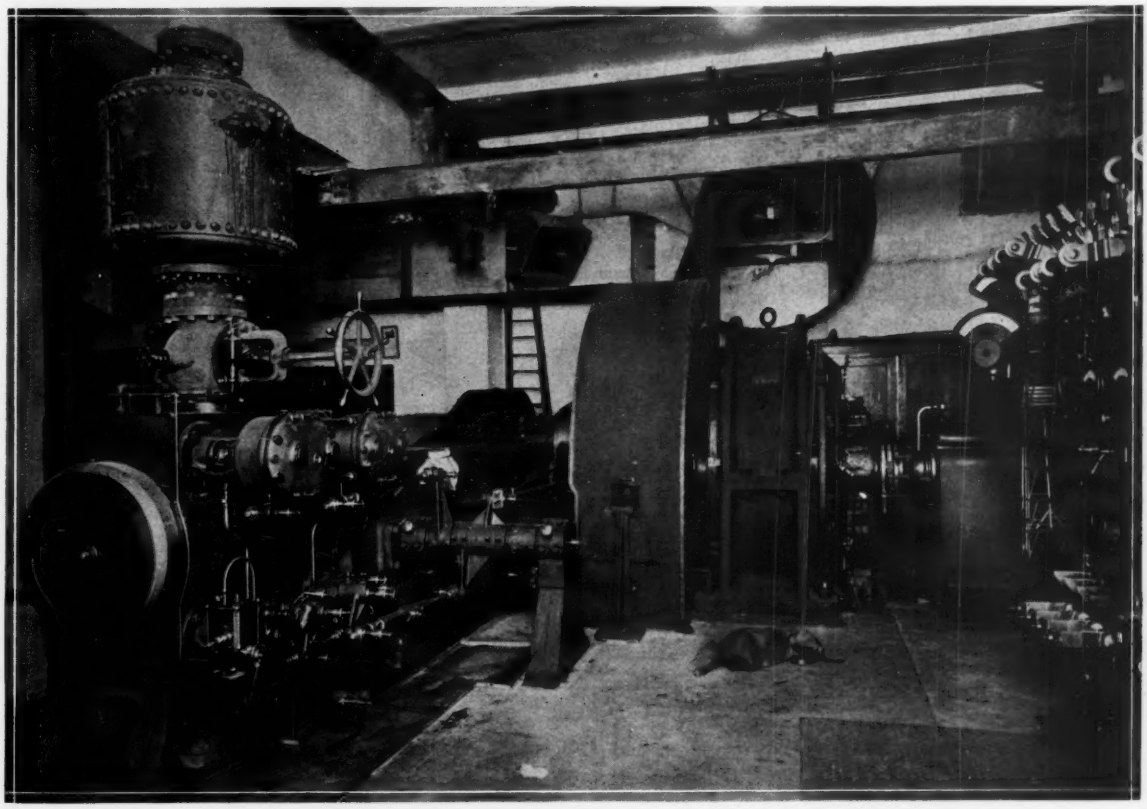


FIG. 1. VIEW OF 350 K. W. UNIT, VENTILATING FAN AND SWITCHBOARD

plan has been efficiently carried out by the consulting engineer Milton C. Hartman and its operation is now in charge of the chief engineer J. G. Harris.

Boiler Room and Equipment

THE boiler room occupies a space directly below the street-level floor of the building, abutting on La Salle Street. It is easy of access for the delivery of fuel and supplies from the street and the Illinois Tunnel, which passes underneath La Salle Street. The total height from firing-floor to ceiling is 32 ft. 6 in.

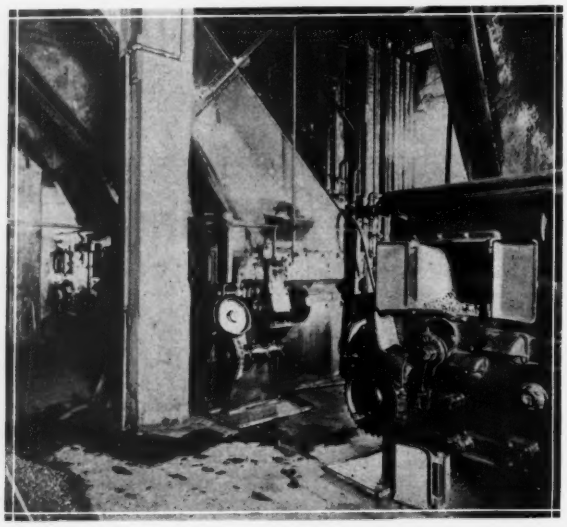


FIG. 2. BOILER ROOM

This unusual height for basement power plants permits the use of horizontal water-tube boilers of which there are 4, in sets of 2. They are regular Heine boilers of 300 hp. rating, 3000 sq. ft. heating surface and carrying a working pressure of 150 lb. The boilers are tiled for the usual 3 passes of gas; the lower row of tiling is of the C type, to conform to the city smoke-inspector's rule, which requires a long travel of gases before allowing them to come in contact with the metal surface of the boiler.

The boilers connect with a common breeching of tank steel which leads into a steel stack 225 ft. high, 7 ft. 6 in. diameter in the clear. This is lined with 2-in. magnesia blocks. The temperature of the uptake gases ranges from 500 to 600 deg. The draft is indicated by an Ellison differential draft gage, so connected at each boiler front, that readings can be obtained either directly above the furnace or in the uptake, as desired, by operating a pet-cock. The average draft carried is 0.35 in. water in uptake and 0.2 in. water over furnace.

The boilers are equipped with Murphy automatic stokers, having a projected grate area of 7 ft. square. During a recent test one boiler developed 557 hp. on a consumption of 45 lb. bituminous coal per hour, per square foot of projected grate area. The speed of the stoker steam engines is controlled by a Lawence automatic, combined damper and stoker-speed regulator.

Coal and Ash Handling

STORAGE of the coal is taken care of in 2 ways. Supply bunkers of 15 tons capacity for each boiler, are situated overhead in the firing lane. Each bunker consists of 2 sections which are respectively connected to each side of the Murphy stoker by inclined spouts. The feed can be regulated or shut off from the firing floor through chain connections, operating the coal feed valves. The coal is supplied to the bunkers either directly from the street level, by teams, or in the usual way, by an overhead bucket conveyor which, in turn, is fed by a cross-feed conveyor, receiving its coal from the main storage bin.

The main storage bin, with a capacity of 400 tons, is a rectangular concrete compartment, occupying a space on one side of the boiler row and extending from the firing floor to the ceiling. The bin can be supplied with coal either from the street direct, through an inclined spout, or fed in the usual way by

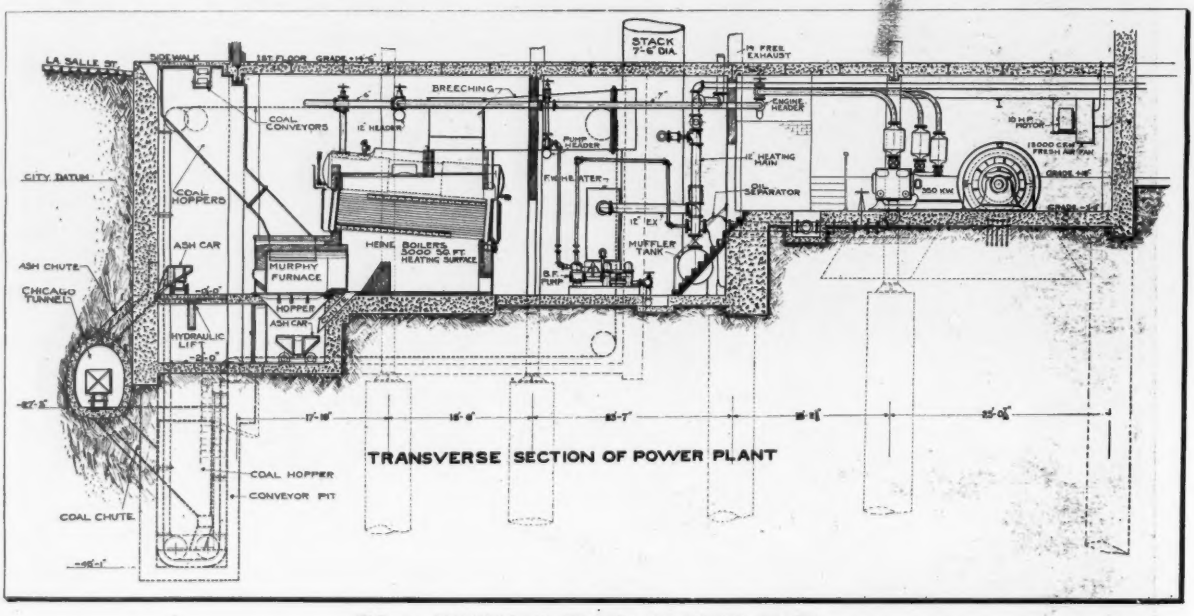


FIG. 5. TRANSVERSE SECTION OF POWER PLANT

a Webster Co. bucket conveyor overhead. This conveyor receives its coal from a pit below the boiler room. This pit in turn is connected with a chute which leads to the Illinois Tunnel, where the supply cars can be dumped directly into the chute. The main conveyor, after receiving its load, rises to the ash pit level, which is 7½ ft. below the firing floor. It then passes horizontally under the storage bin, vertically up at the end and across on top where it dumps the coal into the various sections of the bin as required. It completes its loop by traveling down at the front of the bin and into the conveyor pit. The conveyor is belt driven by a 10-hp. motor.

Coal can be removed from the storage bin in 2 boilers and resort to hand firing or hand charging of stokers.

Before entering the building, the coal can be weighed direct in the Illinois Tunnel cars, a recording beam scale being provided for this purpose.

The storage bin is divided into 2 sections by a one-foot concrete partition wall so that an extensive test can be made at any time by using the weighed coal from one section only.

Ventilation of the bin for protection against fire from spontaneous combustion, is provided by a ventilating shaft of 6 sq. ft., extending to the roof of the building where the air suction is produced by a fan of 6000 cu. ft. capacity.

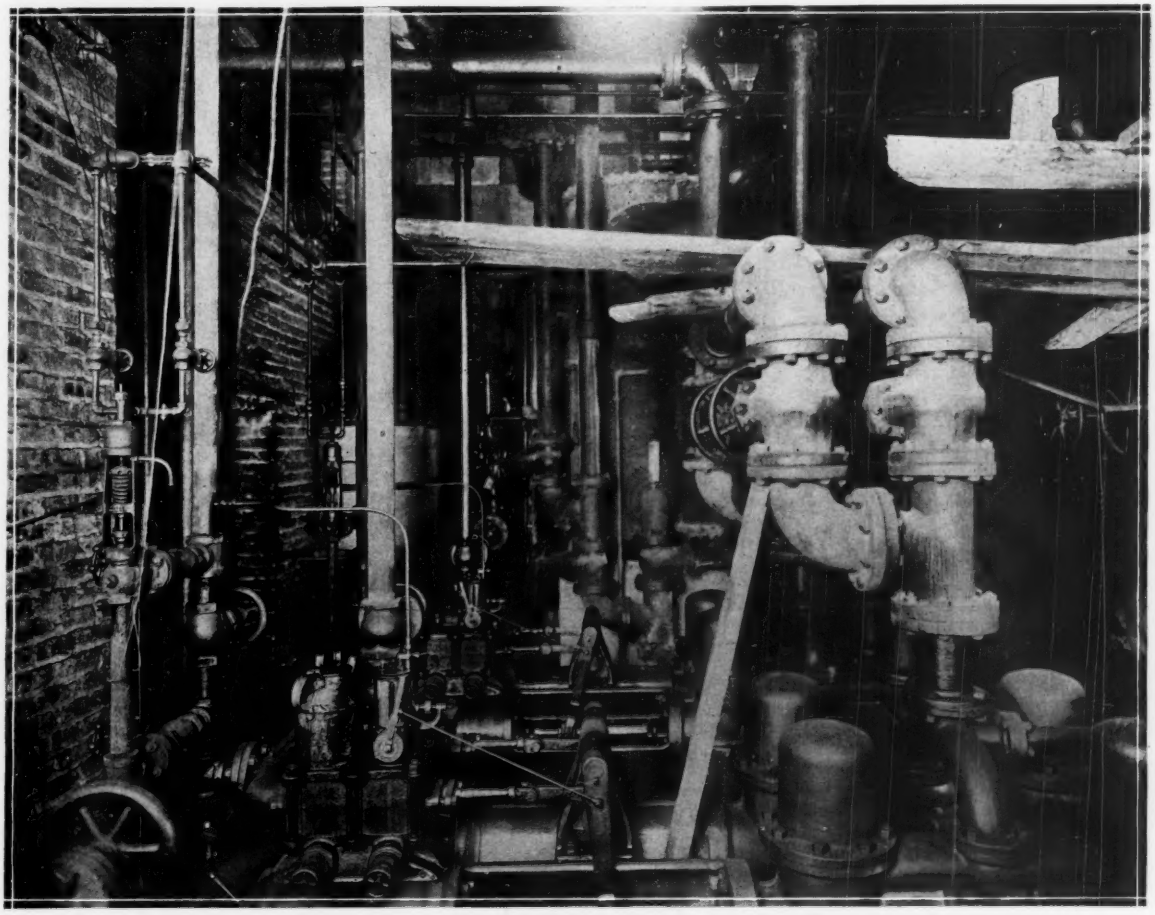


FIG. 3. PUMP ROOM WITH BOILER PUMPS IN FOREGROUND

ways. The regular method is through valves connected to hoppers, which form the floor of the storage bin, and discharging into the buckets of the main conveyor line, during its horizontal travel under the bin. The conveyor can be set to discharge its load either into the top of the bin, as when first receiving the coal from outside, or it can discharge into the cross-conveyor which in turn fills the overhead bunkers in front of the boilers. The second method of removing coal is through 4 emergency gate valves, in the boiler room, and on the firing level. In this case, it would be necessary to wheel the coal to the various

The ashes from the furnaces drop into separate compartments under each boiler, in the ash pit room directly underneath the boiler floor. These compartments are enclosed, sheet steel doors being the only means of access to the interior. In the regular operation of the plant each compartment will contain a push car to receive the ash discharge direct. When full, this car is pushed to one end of the ash pit room, where it can be dumped into a chute leading directly into the Illinois Tunnel cars, or can be raised by a hydraulic lift to the street level, there dumped into and removed by, teams.

Piping and Pump Room

THE pump room is the most interesting part of the plant, if complexity of machinery, piping, and other plant features are considered. One can easily imagine himself as being in a bad railroad wreck, on first entering this room. To a trained eye, however, the arrangement presents itself as a compact and skillfully designed pump room.

The base of the steel boiler stack occupies the center of the room. A 2000-hp. Stillwell open, induced heater and purifier is placed next to the stack. This heater is provided with 2 float valves, one of which governs the amount of return condensation from the heating system entering the heater, while the other provides for the necessary additional water required to make up for leakage and loss through escape of exhaust steam, should the regular supply be insufficient at any time, which occurs especially in summer, when but little exhaust steam is used for heating purposes and the remainder, after heating the feed water, exhausts into the atmosphere.

An overhead tank is provided for the return of the condensation from the various heating systems, to act as storage and supply for the heater. During such times when but little condensation accumulates, as during the summer months, cold water can be pumped into this tank direct and can be partially heated by steam, thus still acting as storage for the heater.

The heater can be bypassed and entirely cut out for repairs if necessary. In this case, the suction for the boiler pumps can be connected direct to the city mains or can get its water from the overhead storage tank; in the latter case, the water would at least be partially heated.

The engine and boiler rooms are placed on the back to back system, the pump room being sandwiched between. All piping is in duplicate or on loop systems, thus effectually providing for pipe failures.

The main steam header is of the loop arrangement. The boiler header section is in the boiler room above the boilers, the engine header in the engine room directly inside the partition wall, connecting loops passing overhead in the pump room at each side wall. Expansion is provided for, by long radius bends, and separators take care of the condensation and entrained moisture. All valves are of the Lunkenheimer 250-lb. rising stem gate valve pattern. The engines are connected to the header by feeders with expansion provision in long radius bends. The boilers are connected to their header by single horizontal U-loop feeders.

The pump header, located in the pump room, forms a loop system, one end being connected to the boiler header, and the other end, to one of the side sections of the main header. All pipe connections from the boiler nozzles to the throttle valves of the

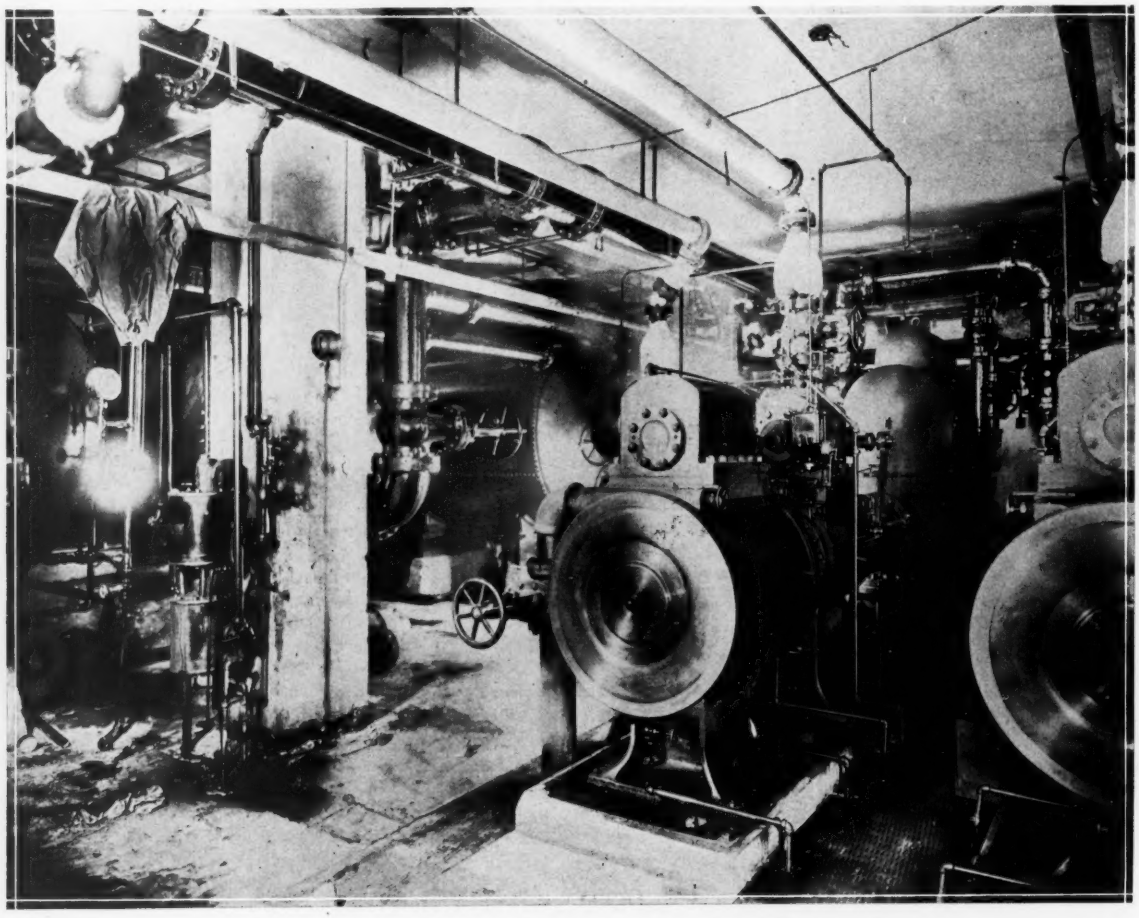


FIG. 4. HYDRAULIC ELEVATOR PUMPS AND PRESSURE-TANKS

main engines are taken from the top, thus providing gravity drainage and preventing any disastrous water hammer.

The pump room contains 4 Advance, 10 by 6 by 2-in. duplex center packed steam pumps, 2 for boiler feed and 2 for house supply. In case of fire, these pumps can be cross-connected to supply the extraordinary demand and pressure necessary.

Suction of the boiler feed pumps can be direct connected to the city mains, or to the main heater, or to the storage tank and heater overhead. The discharge to the boiler supply pipe is in duplicate.

nection to the roof storage tanks, thus permitting of carrying the necessary high pressure without overflow of tanks.

Shone sewage ejector systems are installed in duplicate in the building and supplied with compressed air from 2, 8 by 13 by 10-in. Westinghouse air compressors which maintain a constant pressure of 20 lb.

Exhaust steam from the engines, pumps and auxiliaries passes into an equalizing drum or muffler tank in the pump room, from which it can be governed to supply the necessary amounts for feed-water heat-

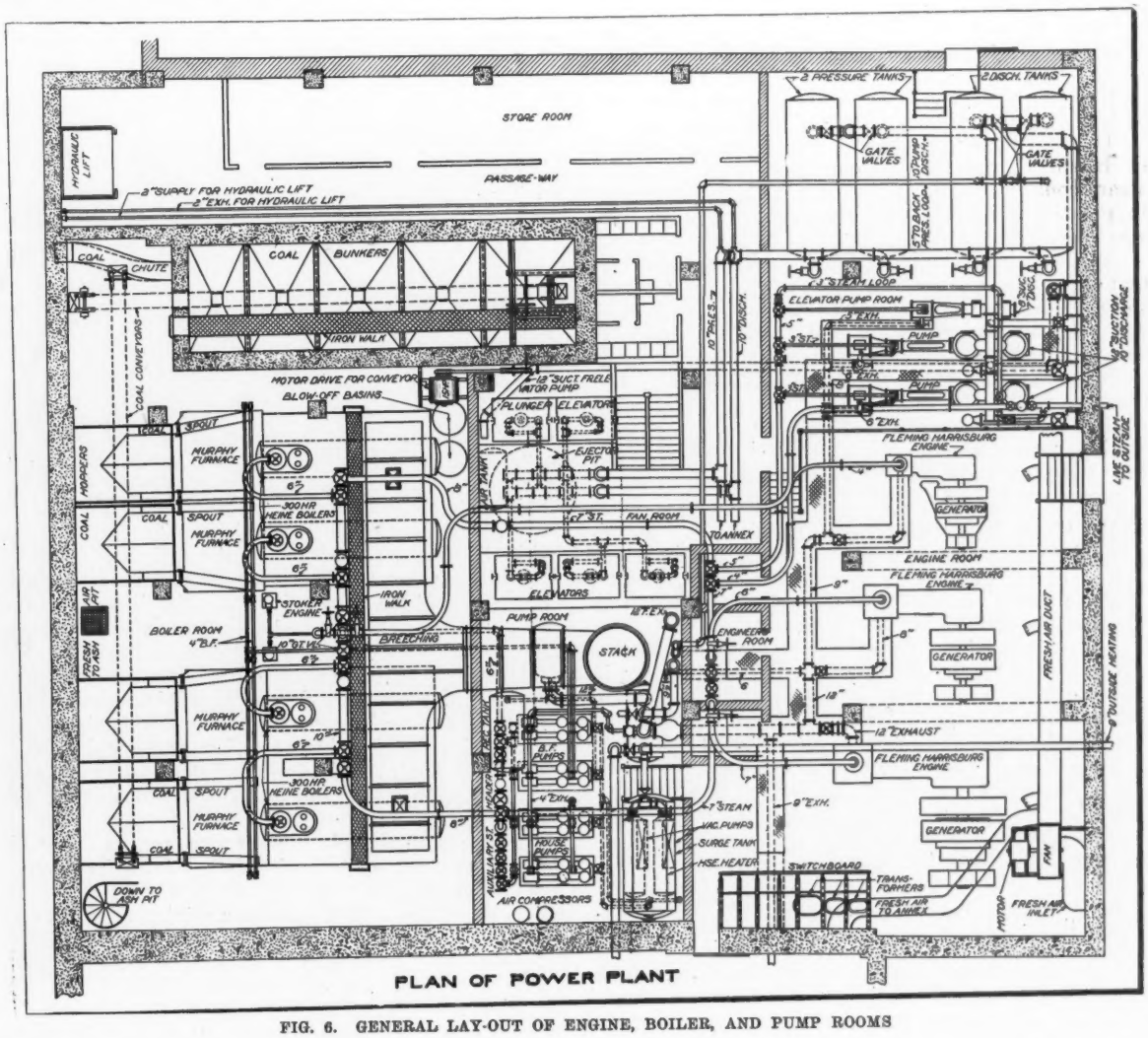


FIG. 6. GENERAL LAY-OUT OF ENGINE, BOILER, AND PUMP ROOMS

The house pumps maintain the pressure and supply for the hot water system installed in the building, the water being heated in 2 tanks equipped with heating coils. To provide for an emergency or excessive drawing of hot water, a storage tank, suitably connected, is placed directly above the heaters.

The house pumps also supply the building with cold water. This is pumped into 2, 2500-gal. storage tanks placed on top of the building, which gives the necessary pressure.

The building is suitably provided with fire protection outlets on each floor. The excess pressure required in case of fire, closes a check valve in the conning, the steam heating system for outside and the Webster building, and the excess goes to atmospheric exhaust. During excessive cold weather or when the supply of exhaust steam is insufficient to meet the heating requirements, live steam, suitably reduced, can be admitted to the heating mains.

A 6-in. exhaust main is separately run to the roof of the building, as an emergency provision in case the back pressure valve fails to operate.

The Monash-Younker vacuum heating system is used, drips and condensation returns being taken care of by 2 Burnham, single 8 by 10 by 12-in. vacuum pumps.

Engine Room Equipment

POWER equipment in the engine room consists of the following—Triumph Electric Co. generators, direct connected to Fleming-Harrisburg, simple Corliss valve, steam engines of their latest type, with main and outboard bearings, water-cooled.

One for 350 kw., 150 r.p.m., 115-230 v.;
One is for 200 kw., 170 r.p.m., 115-230 v.;
One is for 100 kw., 225 r.p.m., 115-230 v.

The generators are all of the 3 wire direct-current type, using static transformers as balancers. A 50 per cent overload can be carried for 3 hours or 25 per cent continuously.

This 7-panel switch-board, built by the States Electric Co., has the usual equipment of following make, Duncan watt-hour meters, Keystone ammeters and voltmeters, Walker motor-controlled rheostats and I. T. E. circuit breakers and switches.

Under a recent test by the consulting engineer, M. C. Hartman, the 100-kw. unit showed the excellent steam consumption for a noncondensing engine of 19.8 lb. per i.hp. per hour. A 100 per cent unbalanced load was carried for one hour by the generator.

The usual pressure carried, with the heating system on, ranges from 2 to 3 lb. The heating system is so arranged that 75 per cent of the load will give the usual back pressure and in cold weather, when the supply of exhaust steam is insufficient, the live steam, properly reduced, will furnish the remainder at a pressure of about 5 lb.

The engine room is provided with a one-ton overhead trolley crane for the rapid and easy repair or inspection of the various units.

Elevator Equipment

THE hydraulic elevators installed in the building are of the standard plunger make, pressure tanks and pumps being situated in the engine room. The 2 pressure tanks are of 3000 gal. capacity and carry a pressure of 200 lb., which is maintained by 2 9½ by 7½ by 10-in. Westinghouse air compressors. The 2 return storage tanks are of like capacity.

Hydraulic pumps are of "American" make of following size: 2 18 by 28 by 5½ by 29-in. simplex compound and one 20 by 10 by 20-in. simplex pump. Steam is supplied to these pumps by a loop header, connected with the steam engine header on one end and the boiler header on the other.

The engine room is properly ventilated and cooled by means of a direct connected motor driven fan of 15,000 cu. ft. capacity. The fire room is well provided with ventilation and cooling drafts by means of two 7 by 2 ft. ventilating shafts extending from the street level to within 10 ft. of the firing floor. The interesting feature of the fire and engine room ventilation is the suction, caused by the 18-in. clear space about the stack, extending to the roof of the building. This not only thoroughly ventilates the power plant, including pump room, but acts as an insulating medium for the hot stack in its passage through the various floors.

A direct connected Spencer Turbine Vacuum Cleaner, installed in the basement, is suitably connected for outlets on every floor, thus affording proper cleaning facilities.

The total supply of steam leaving the building is measured by means of a Gebhardt steam flow meter, and feed water entering the boilers is measured by a Venturi indicating and recording meter, the dials of which are placed in the chief engineer's office. The amount of coal supplied to the overhead bunkers can be easily determined; ash in the enclosed ash-pits can be readily weighed and all necessary readings of drafts and flue analysis easily taken so that a test of the plant can be made at any time. The Venturi indicating meter showing pounds of water evaporated per hour is a ready means of determining the ratio of the working load of the boilers to their rated capacity.

Proper nozzles are placed in all the steam pipes so that the steam consumption can be obtained at any time by the Gebhardt steam flow meter and the efficiency of the various machines obtained.

Besides furnishing light, heat, and power, for its own use, this plant will supply neighboring buildings, as follows:

The 8-story Commerce Building—Light, heat and power.

The 8-story Traders Building—Light, heat and power.

The 4-story Imperial Building—Light, heat and power.

The 6-story Victoria Hotel Building—Light, heat and power.

The 8-story Kaiserhof Hotel Building—Light, heat and power.

The Kaiserhof Annex—Light, heat and power.

The 6-story Jenks Building—Light, heat and power.

The 12-story La Salle Building—Light, heat and power.

IN AN ARTICLE recently noted the following occurs: "Size of discharge pipe, gallons of water delivered per minute and ratio of lift to submergence remaining constant, the free air required per minute will be the same regardless of whether the lift is 10 or 100 ft."

This is at variance with theory, with the practice of engineers in figuring free air requirement, and also with the actual experience of the writer. Under the conditions as stated engineers figure the free air required would be proportional to the lift. Theoretically, the free air required does not increase proportionally with the lift. The statement that "the cubic feet of free air per gallon of water raised increases as the ratio increases for a given size of discharge pipe, and for a given ratio it decreases as the size of the discharge pipe increases," agrees with theory. Also the free air required per gallon of water decreases with increased submergence, the lift remaining constant.

The statement that "a curve representing the horsepower per gallon of water raised for varying depths and constant lift will at first decrease as the depth increases until it reaches a minimum point, after which it increases" is not in accordance with theory. Theoretically, commencing at 10 per cent submergence, the horsepower of the air required increases by a constantly decreasing ratio for each percentage of increase in the submergence. Economy in horsepower, therefore of fuel, lies in the direction of lower percentage of submergence, while economy in size of compressor plant, piping, etc., lies in the direction of increased percentage of submergence up to, say, 60 per cent.

For any given well the submergence, lift and quantity of water discharged being known, the proper diameter of discharge and air pipe may be found, and the whole adjusted to the most economical working condition.—Iron Age.

A NEW SUBMARINE CABLE between England and France has resulted in telephonic communication between England and Switzerland.

THE LOCOMOBILE

A Steam Unit for Taking Advantage of High Superheat. Latest American Development

By Warren H. Miller

PRACTICAL UTILIZATION OF SUPERHEATED STEAM has been the goal towards which all engine builders have been working for the last 10 yr. Every technical school graduate is familiar with the economies that are theoretically possible from its use, and is equally conversant with the limitations of ordinary saturated steam. With the latter, ⅓ of the steam produced by the boiler is bound to be bypassed

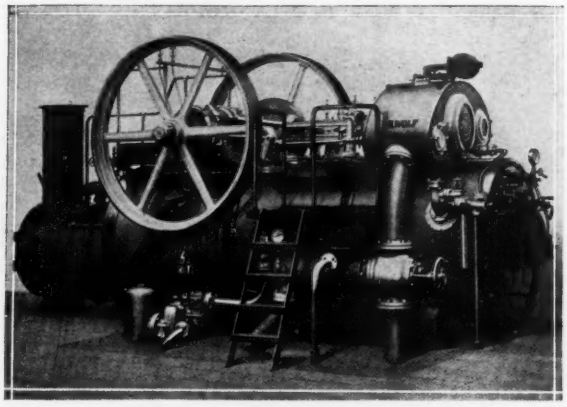


FIG. 1. EARLY TYPE OF WOLF LOCOMOBILE WITH STEAM DOME

through the cylinder and enter the exhaust without producing any useful work. It condenses on the cylinder walls during admission and re-evaporates during expansion, thus escaping to the exhaust without adding a pound to the mean effective pressure. Highly superheated steam is a perfect gas, a poor conductor of heat, will not condense on the cylinder walls, and occupies 20 to 30 per cent more volume to the pound than its equivalent weight of saturated steam. It is therefore the ideal material for use in a steam engine.

In practice in the ordinary boiler and engine plant it presents so many insuperable difficulties in its use that but little progress has been made in introducing superheaters in the average power plant. Long lines of piping will not carry the highly superheated steam effectively; cylinder radiation reduces it to a saturated state before admission is accomplished; there is no way to reheat it for the low pressure cylinder; ordinary packing and valve gear will not handle it; and the problem of keeping the superheater clean develops into a nuisance of the first class. But, granted that superheated steam can be used practically, let us look over the economies that will certainly become coal-pile facts.

Possible Saving

STEAM consumption of the single-valve saturated steam engine is generally admitted to be around 23 lb. per i.hp. With complicated and highly specialized cutoff gear it can be reduced to 17 or even 15 lb. Take the 25-lb. engine and eliminate its cylinder condensation, ⅓ of the whole steam consumption, a saving of 8 lb. is then to be looked for, making 17 lb. as the probable steam consumption. Assume that the superheat is such as to increase the volume per pound 20 per cent; this will give a further saving of 5 lb. per hour per horsepower, and the theoretical economy drops to 12 lb. Suppose we arrange our plant to eliminate piping losses, cylinder radiation and boiler radiation, in all 10 per cent on our steam output, gaining thereby 2 lb. more; the total economy of our plant would then be 25 — 8, — 5, — 2 lb. or 10 lb. of steam per hour per horsepower.

This is exactly what the locomobile does in practice, and has been doing on the Continent for the last 10 yr. In fact, it does better than that, 2 types of the Wolf locomobiles giving an average economy of 7.2 lb. per effective horsepower per hour right along in daily service. And this is not 1 or 2 engines, tested under blue-ribbon conditions by university professors; it is 30,000 of them, in all kinds of service, all over Europe and her trade dependencies.

Early Development

THE first time I saw a locomobile was at Bertry, in France in 1909. I noted an ad. in La Revue Electrique, of a pair of engines at Bertry driving electric generators with a daily efficiency of 3.6 kilograms (7.94 lb.) steam per effective horsepower hour. What sort of engines could these be? The photograph did not help much, for it showed no visible cylinders, the boiler did not look like anything else under the sun, and the generators could not have been over 30 kw. I went to Bertry and there began my acquaintance with the locomobile. Since then I have seen hundreds of them. In Belgium at the Brussels Exposition they furnished nearly all the light and power for the expo-

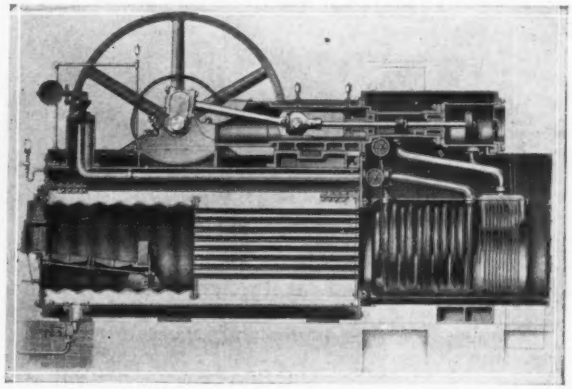


FIG. 2. LONGITUDINAL SECTION OF RECENT TYPE WOLF LOCOMOBILE

sition, 2 units, a Lenz 1000 hp. and a Wolf 650 hp., running in parallel (d.c.), doing the trick on 9 lb. of steam per brake horsepower hour. Standing on the engine platform no vibration could be felt, the whole 1000 horse of the Lenz plant took up but 35 by 22 ft. floor space, and tachometer measurements convinced me that they would be just right in regulation for the most exacting 60-cycle alternators driven in parallel.

Later I went to Germany, the home of the locomobile. I wanted to see how they kept up on daily service, what the coal accounts showed, whether one man alone really could run and fire a 250-hp. locomo-

bile without doing more work than the law allows;—and above all I wanted to see the practical care of a superheated steam plant by an ordinary mechanic, just how much trouble he would have with rods and packing and lubrication; in a word did the locomobile constitute a nuisance, such as do a great many refinements in steam practice on our side of the water?

I went all over Germany on the trail of the locomobile, saw them being built at the rate of over 2000 a year, in all sizes from 40 to 1200 hp.; saw them run at almost full economy on half load; saw them fired automatically, burning oil fuel, running on peat, lignite, straw, sawdust and good Westphalian coal; and the average daily economy was 1.3 lb. of coal per brake horsepower hour for compounds and for simple as shown in the data sheets.

These were facts; the locomobile was making good, had been for over 10 yr. Tests made by Josse, Schroeter, Guthermuth, Mathot, showed better than 9 lb. The Czar's 130-hp. engine at the Peterhof palace was doing 7.5 lb. of steam, but the rank and file could be depended upon for between 9 and 10 lb. of steam per brake horsepower, and men were doing business on that basis. It looked as if the engineers of the good old U. S. were missing something with their 25-lb. engines. There was no use being skeptical about it. Europe doesn't care a rap whether we use 2 lb. or 100 in our engines and has no desire to come over here and reform us. Our tariff wall and the metric system effectually prevent importation of locomobiles; if we are going to use them the engine must be American-designed and American-built. Every bolt, pipe-thread, and rivet on a French or German locomobile is on the metric system standards, and we have hardly a shop in the country that could furnish repair parts on short notice.

American Development

ALL of which I duly chronicled in the engineering press, drawing editorials by the column. It looked like a good chance for some enterprising builder to jump in and put an American locomobile on the market. The Buckeye Engine Co. of Salem, Ohio, got busy, and in just a year's time from starting work invited the writer to come out and test the first American locomobile. As this design was started with 10 yr. of German experience to draw on it began with the latest, and best type extant in Europe, improved it to suit our practice, and the result is a machine that is the equal of anything on the other side.

I will merely mention that the earlier German locomobiles had but one superheater coil and jacketed their cylinders in the steam dome, reaching a limit of economy of about 9 lb. By adding a second superheater for the low-pressure cylinder and jacketing the cylinders in the chimney uptake, 2 more pounds of economy were produced, making 7 lb. of steam as the ultimate economy,—and I believe it is the world's record for steam consumption. This type is being extensively manufactured abroad, is the coming machine, and is where the Buckeye people started in designing the engine here shown.

Essential Features

IN the first place, to eliminate long lines of steam piping, decrease floor space and make a second superheater practicable, the engine is mounted on the boiler shell. This feature is common to all locomobiles, of every make and size from 40 to 1000 hp. (and the generator is mounted up there too in Continental engines). By this arrangement we are able to run a short pipe from the steam dome inside the boiler to the high-pressure superheater, and from it direct to the engine, exposing no pipe at all to radiation. The exhaust from the high then goes direct to the low-pressure superheater and returns to the low-pressure cylinder again without exposing any of it to radiation. Thus at a single stroke we avoid one of the principal difficulties inherent in using superheated steam where the boiler is in one room and the engine in another.

Is this mounting of the engine on the boiler a detriment? Far from it. Not only is there no strain from the engine transmitted to the boiler, but this grouping the 2 together led to one of the principal operating economies in Europe,—eliminating the fireman. We are apt to think of the boiler as a dirty contrivance, with its top covered with ash dust from cleaning fires. That is true and unavoidable in a boiler serving a saturated steam engine. Such a boiler in a 250-hp. plant will have a grate 7 ft. wide by 6 ft. 6 in. back to the bridge wall, but the 250-hp. locomobile boiler has a grate only 3 ft. by 3 ft. 6 in., as it uses only a third as much coal. Such a fire one man can easily tend and still have plenty of time to look after the engine, and as both are under the care of a man of superior intelligence both are kept clean and polished, at maximum efficiency, automatic firing is at its best and the fires are cleaned and ashes dumped entirely under the furnace hood.

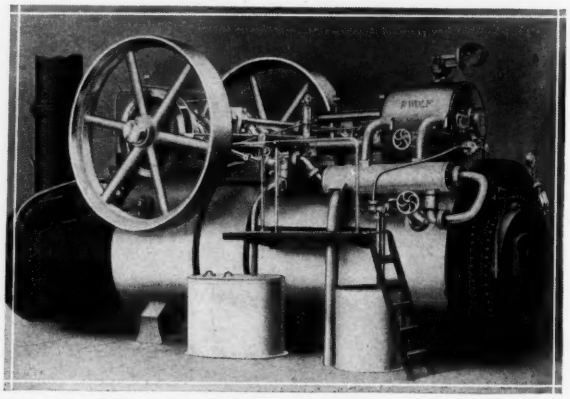


FIG. 3. SUPERHEAT LOCOMOBILE WITH SIMPLE ENGINE

The next feature of interest, common to all locomobiles, is the removable tubes and corrugated furnace. It is wonderful how long we have been in coming to it on this side of the water, but the best way to clean a boiler is not to send in a man to creep around over the tubes and under the shell, chipping and scraping as best he may, but to take out the tubes and furnace entirely, so that both the shell and tubes can be gotten at properly. Again, this could not be done except with a boiler having a small grate and furnace in proportion to its output, as in the locomobile. The front and rear tube sheets are not riveted to the shell but bolted with stud bolts and made tight with boiler gasketing, just as is done with a manhole. The boiler insurance people see nothing to criticize in this; in fact they will rate the boiler better as the years pass, because it can be thoroughly cleaned.

Superheating

WE now come to the heart of the locomobile; the superheaters, and what they do to the steam. The boiler makes it at 160 lb. pressure,—350 deg. F.,—and delivers it saturated to the first superheater. Now the tubes have been especially designed short so as to

reject the flue gases to the superheater at around 800 deg. Your heat is then occupied, not in raising an abnormal amount of steam for a wasteful engine, but in superheating it so that the engine will not waste it. The steam enters the superheater coil at the far end and flows counter to the flue gases, being raised in the process from 350 up to 750 deg. It is now a nonconducting, noncondensing gas, and a pound of it occupies 1.26 times the volume of a pound of saturated steam, so that it will turn out 26 per cent more work.

It enters the high-pressure cylinder and expands down to 260 deg., where it would begin to condense, having reached saturation; but it is then sent to the second superheater coil which is a low-pressure, multiple-tube affair and is reheated to nearly 400 deg. It is now fit for the low-pressure cylinder which it enters, doing its work without condensation, and then exhausts into the feed-water heater where its remaining heat suffices to raise the feed water to 125 deg. Meanwhile the flue gases have lost heat down to about 360 deg. and are just right to jacket the cylinders without abstracting any heat from the steam inside.

Here we have the story of superheated steam, giving its scientific economy in practice. If the superheater was away off in some boiler brick setting you could not clean it enough for any real efficiency, and the expansion strains set up in it on load changes would soon wreck its flanges. Owing to the small difference in heat-transfer coefficient between superheated steam and flue gases the superheater must be always clean. In Germany they clean it once a day, as regularly as they blow down the boiler. To do it without making a nuisance of it you must have, first a coil superheater without any dust-catching flanges, and second a revolvable steam jet. This latter is simply a steam pipe, perforated with holes, which is swung around by a handle on the boiler front. It takes about 5 min. slow turning, once a day, to blow off all the soot on the coil, the jets from the revolving steam pipe sweeping it off as it is turned. But this is not all the story of the locomobile. There is an automatic interchange between the work of the boiler tubes and superheaters, so that the less steam called for, the greater the efficiency of the superheat, and this acts practically in making the steam consumption the same at all loads. Run a locomobile at half load, full load and ¼ overload and the steam consumption will still stick around 9 lb. at all of them. This is a unique feature of the locomobile and is common to all makes and sizes. It was discovered and explained by Josse and Gutermuth in the Charlottenberg and Darmstadt tests, but I have seen it work out in practice in Germany where a 220-hp. locomobile was running a screw works in the slack season on 100-hp. output, and the economy was still 2.66 lb. of lignite (or 1.3 lb. of 13,500-B.t.u. Westphalian soft coal), only a fraction of a pound less than the full load daily record. And the economy is also independent of the size. The world's record is held by a 130-hp. Wolf machine and was held, up to 2 yr. ago, by an 80-hp. "Russian" type Wolf engine. They make the same thing in 650-hp. I saw one running in the stronghold of the Lenz locomobiles in Mannheim—and it was not equalling that of the 130-hp. by half a pound. They average 9 lb. at all horsepowers, and you will note

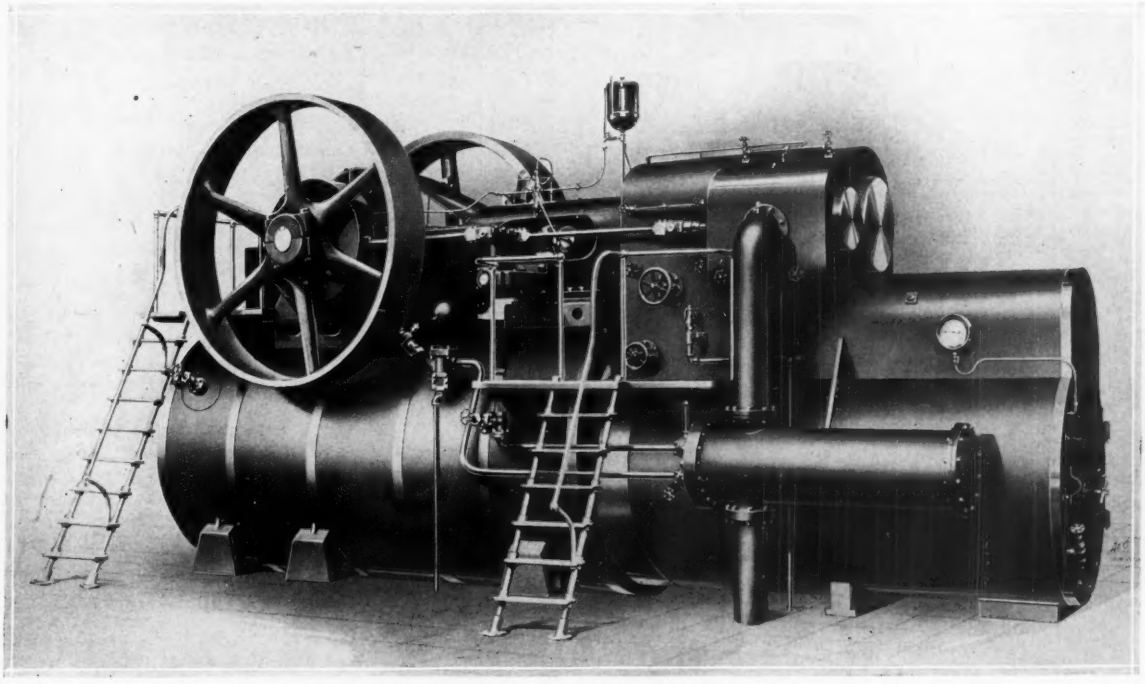


FIG. 4. 175-HP. BUCKEYE-MOBILE

DISTRIBUTION OF WOLF LOCOMOBILES IN 1910

Woodworking industries	1885
Potteries	1400
Iron and metal shops	1429
Electric light and power	1615
Construction plants	337
Mill drive	1253
Mine machinery	837
Paper mills	224
Stone crushing, etc.	167
Textile mills	337
	9,484

from the graphic tests in the Practical Tables and Table I that our own Buckeye-mobile makes about the same.

As to their growth in Europe, over 50,000 of them are running on the Continent today and the appended table will give you some idea of the distribution of the locomobile for the different classes of engine drive in the industries. That is the record of only one German company. It will not be many years before the Buckeye people will have something of the same sort to show, as I learn that they already have a line of 5 or 6 sizes on the market. I have no financial interest whatever in the locomobile, but from a scientific point of view it is only equalled in interest by the gas turbine and the uni-cylinder engine, both now in the embryo stage in the European laboratories.

DAILY SUMMARY OF BUCKEYE LOCOMOBILE ON SHOP LOAD.

Date	Time		Hrs. Run	Total Lbs. Coal	Coal per Hr.	Total K.W. Hrs.	K.W. Hr. per Hr.	Load Factor	Coal per K. W.Hr.	Coal perI.H. P.Hr.	Method of Operating	Remarks
	Start	Stop										
Jan. 30	8:30 A.M.	5:30 P.M.	9	2260	251	715	79.5	63%	3.16	1.84	Condensing	Salem Mine Coal
Feb. 10	12:30 P.M.	5:30 P.M.	5	1486	297	465	93.0	74.4%	3.20	1.895	Condensing	Salem Mine Coal, Poor Grade. Full of Dust
Feb. 11	12:30 P.M.	5:30 P.M.	5	1474	295	480	96	76.8%	3.12	1.93	Non-Condensing	Pittsburgh Coal 14348 B. T. U.
Feb. 12	12:30 P.M.	5:30 P.M.	5	1232	246.5	440	88	70.5%	2.8	1.65	Condensing	Pittsburgh Coal 14348 B. T. U.
Feb. 14	12:30 P.M.	5:30 P.M.	5	1361	274	465	93	74.4%	2.95	1.75	Condensing	Pittsburgh Coal 14348 B. T. U.
Feb. 15	8:00 A.M.	11:30 P.M.	3½	782	227	285	81.4	65%	2.745	1.63	Condensing	Pittsburgh Coal 14348 B. T. U.
Feb. 17	8:00 A.M.	5:30 P.M.	7¾	1900	245	720	93	74.4%	2.64	1.56	Condensing	Holwick Coal 14398 B. T. U.
Feb. 20	1:45 P.M.	5:30 P.M.	3¾	1088	290	325	86.7	69.3%	3.35	1.97	Condensing	Salem Coal (Full of Dust) 13843 B. T. U.
Feb. 21	1:05 P.M.	5:30 P.M.	4,5/2	1279	290	400	90.6	72.5%	3.195	1.89	Condensing	Salem Coal (Full of Dust) 13843 B. T. U.
Feb. 24	6:30 A.M.	5:30 P.M.	10	3032	303.2	925	92.5	74%	3.59	1.94	Condensing	Salem Coal (Much Dust) 13843 B. T. U.
Feb. 25	8:10 A.M.	2:30 P.M.	5¾	1290	242	433	81.2	65%	2.98	1.74	Condensing	McNab Hard Coal 14.09% Ash. 12723 B. T. U
Feb. 25	2:30 P.M.	4:30 P.M.	2	525	262½	186	93	74.4%	2.82	1.68	Condensing	McNab Hard Coal and Salem Coal 75% 25%
Feb. 26	6:30 A.M.	5:30 P.M.	10	2548	254.8	865	86.5	69.2%	2.94	1.73	Condensing	Salem Coal, Run of Mine 13843 B. T. U.
Feb. 27	6:30 A.M.	5:30 P.M.	10	2892	289.2	990	99	79%	2.93	1.74	Condensing	Salem Coal, Slack 13760 B. T. U.
Feb. 28	6:30 A.M.	5:30 P.M.	10	2683	268.3	915	91.5	73.2%	2.935	1.74	Condensing	Salem Coal, Slack 13760 B. T. U.
Mar. 1	6:30 A.M.	11:30 P.M.	5	1301	260	460	92	73.5%	2.83	1.68	Condensing	Salem Coal, Run of Mine 13912 B. T. U.
Mar. 3	8:10 A.M.	5:30 P.M.	8½	2341	281	780	93.6	74.8%	3.00	1.78	Condensing	Salem Coal, Run of Mine 13912 B. T. U.
Mar. 4	6:30 A.M.	5:30 P.M.	10	2805	280	980	98	78.4%	2.86	1.706	Condensing	Salem Coal, Run of Mine 13912 B. T. U.
Mar. 5	6:30 A.M.	5:30 P.M.	10	2717	271.7	870	87	69.6%	3.12	1.84	Condensing	Salem Coal, Run of Mine Contains Slate 13912 B. T. U.
Mar. 6	6:30 A.M.	5:30 P.M.	10	2641	264.1	876	87.6	70%	3.02	1.78	Condensing	Salem Coal, Run of Mine Rogers Coal in Use at 11 A. M. 13912 B. T. U.
Mar. 7	6:30 A.M.	5:30 P.M.	10	2589	258.9	845	84.5	67.6%	3.06	1.80	Condensing	Rogers Ohio Coal 13515.37 B. T. U.
Mar. 8	6:30 A.M.	11:30 A.M.	5	1120	260	390	78	62.4%	2.87	1.936	Condensing	Rogers Ohio Coal Salem Run of Mine, Mixed

He has addressed a letter to manufacturers throughout the country, calling attention to the fact that the space for engineering exhibits is limited, and such exhibits must, therefore, be selected, so that it is advisable for those wishing to secure space, to apply early. Exhibit space is free, and already keen competition is manifest in securing locations. Blank applications for space and other information can be secured by addressing Mr. Hardee, Exposition Building, San Francisco.

ENGINEERING EXHIBITS AT THE PANAMA EXPOSITION

PRESIDENT Moore, of the Panama Pacific International Exposition, has appointed as Chief of the Liberal Arts Department, in which the engineering exhibits will be made, Theodore Hardee. This department includes besides the engineering, architecture and manufacturing processes, such as printing, engraving, paper-making, typography, chemical instruments, musical instruments and other groups, making 15 in all and divided into 121 classes.

Mr. Hardee has had experience at the St. Louis World's Fair, and as St. Louis representative of the Lewis and Clark Exposition, at Portland.

A GERMAN ELECTRICAL FIRM, competing with American concerns in the same business, has carried off a $3,000,000 contract for an electrical plant in Chile, to be constructed with American capital. This contract covers only the first installations, and the German concern will be on the ground for further extensions which are expected ultimately to amount to several million dollars more.

The plant is that of an American exploitation company, which foresees a great development of the west coast of South America after the opening of the Panama Canal, and is preparing to work copper deposits in Northern Chile. The first contract covers the construction of a main electrical station on the coast and a secondary station, 125 miles distant, to which the power is to be transmitted on a high-tension circuit.

NORFOLK & WESTERN RAILWAY CO. is reported as having plans prepared to construct steam power electric plant at Bluestone Junction, W. Va., to develop 32,000 hp.; machinery to include 3 steam turbine engines and generators, each with capacity of 8000 kw., to distribute electricity for operating Elkhorn branch of railway.

HEATING AND VENTILATING LARGE BUILDINGS

Principles of Vacuum Heating

By Charles L. Hubbard

UTILIZATION of exhaust steam for heating purposes has already been considered to some extent. The value of this is evident from the fact that only about 10 to 15 per cent of the heat is extracted from the steam in passing through the engine, which leaves the remainder available for heating. Of this remainder, approximately 1/5 may be utilized in heating the feed water during the nonheating season. In the winter, when the heating plant is in use, the makeup water may be drawn into the receiving tank and fed into the boilers with the return. If, however, there is more exhaust than can be used for heating, then the feed-water heater should be in service continuously, winter and summer.

The principal objection which has been brought against the use of exhaust steam for heating has been the higher back pressure required on the engines, resulting in a loss of power nearly proportional to the ratio of the back pressure to the mean effective pressure. Probably this objection has been somewhat overestimated in many cases, still the great height of the modern office building and the long distances which it is often necessary to carry steam in institutions, calls for quite an appreciable rise in pressure to get a satisfactory circulation through the radiators at the extreme end of the line unless the pipes are made of special size. As a rule, an engine works better if the back pressure can be kept down to the point for which it was designed, and this can be easily done if a vacuum system of heating, so called, is employed. Generally speaking, any system of heating

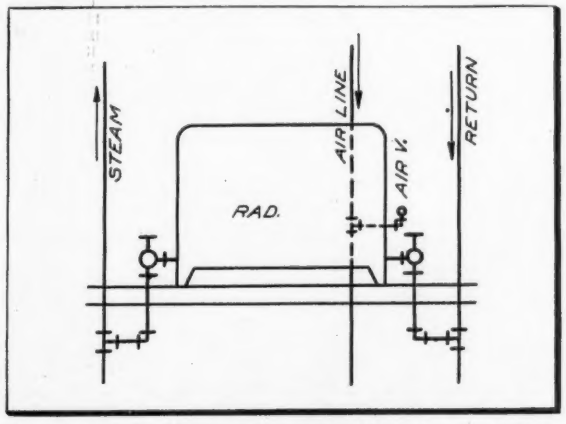


FIG. 1. VACUUM SYSTEM WITH SUCTION LINE ATTACHED TO AUTOMATIC AIR VALVES

in which the pressure in the return mains or in the pipe lines leading from the air valves is less than that of the atmosphere is known as a vacuum system.

Effect of Vacuum

ONE important point which should be borne in mind is that the vacuum or reduced pressure in the return system under normal working conditions has nothing to do with the circulation of steam through the supply mains and radiators, except as it frees them of air and condensation. The flow of steam from the basement main to the radiators is produced solely by the drop in pressure caused by the condensation within them, exactly the same as in the ordinary pressure system, and not by the suction attached to the returns.

Supply and return systems are entirely cut off from one another by the thermostatic valves upon the return ends of the radiators, except when they are discharging air or condensation. If the radiator returns were open all the time, then the pressure in the

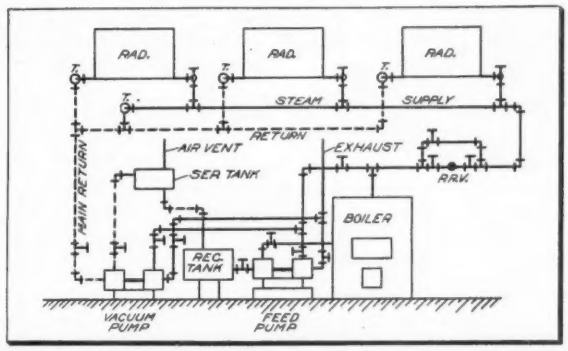


FIG. 2. VACUUM SYSTEM WITH SUCTION LINE ATTACHED TO RETURN ENDS OF RADIATORS

radiators would be reduced, and the flow of steam through the supply mains correspondingly increased. This, however, is not the case, except when discharging condensation, the relative volume of which is so small that it has no appreciable effect upon the pressure in the radiator. If steam were allowed to flow through the radiators into the return, it would not only unbalance the pressure throughout the system by short-circuiting through those radiators nearest the source of supply, but would also result in a large waste of steam, as there is no advantage in supplying more steam to a radiator than can be condensed within it. It may be asked how, under these conditions, a vacuum system can assist in the flow of steam to the radiators or reduce the back pressure upon the engines if it is confined to the return piping by means of the thermostatic valves.

The flow of steam to the radiators is improved simply because the air and condensation are removed more quickly and thoroughly. Theoretically, there is no difference between forcing the air out under pressure and drawing it out by suction; but in practice there are certain advantages in the latter method. When suction is applied to the main return, all parts of the piping are affected the same if there are no leaks to produce short-circuiting. When the air is forced out there is danger of its being pocketed in remote parts of the system unless great care is taken in the arrangement and proportioning of the different branches. Furthermore, there is often difficulty in maintaining an even pressure throughout the return system and this frequently results in holding back the condensation in certain lines of piping, thus causing water hammer and surging.

The effects of forcing out the air by pressure and of drawing it out by suction have been likened to forcing a flexible wire or rod through a pipe or conduit having numerous branches and pockets, and to drawing it through with straight runs of piping of com-

paratively short length; one method may work as well as the other, but if the path is complicated by abrupt turns and dead ends the process of drawing the wire through will be found much the simpler. In like manner, low pressure steam will easily flow through the short distances and direct paths found in a well planned heating system in a building of small or medium size, and will quickly and easily clear it of air without complicating the equipment with pumps and ejectors.

But in the case of office buildings, and large public institutions, requiring extended and complicated systems of piping, it is difficult to foretell just how the flow of steam and air will take place; and there is more or less danger of sluggish circulation and air pocketing under the low pressures commonly carried. A substantial reduction in back pressure upon the engines is brought about in this way.

While it is true that the reduced pressure, or vacuum, in the return system is cut off from direct communication with the radiators by the action of the

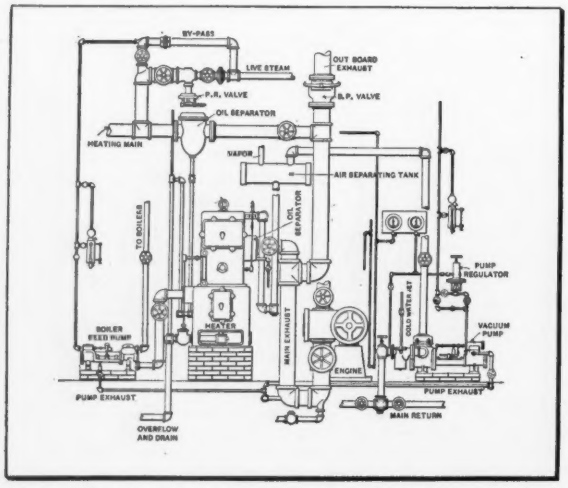


FIG. 3. ENGINE ROOM PIPING FOR WARREN WEBSTER SYSTEM OF VACUUM HEATING

thermostatic valves, there is still a direct relation between the two. The minimum pressure in the returns is fixed by the tightness of the piping and the capacity of the vacuum pump, while the pressure in the supply system, when the exhaust does not exceed that which may be condensed in the radiators, may be made anything desired, from slightly above that in the returns, by a proper adjustment of the pressure reducing valve admitting live steam, and the back pressure valve exhausting outboard. As a matter of fact, the 2 pressures are given just enough difference so that there will be sufficient suction to draw the air and condensation from the radiators into the returns when the thermostatic valves open. Suppose this difference to be 1 lb.; then with a pressure, say 6 lb. below atmosphere in the returns, there will be a pressure of 5 lb. below atmosphere in the supply system, which is also the back pressure on the engines.

If there is more exhaust steam than can be utilized in the heating system, so that a portion of it must pass off through the back-pressure valve, it will be impossible to carry a pressure on the supply system less than atmospheric. But when a certain amount of live steam is required, the pressure may be varied over a considerable range by the means already described.

Advantages of Vacuum

IN summing up the advantages of vacuum heating for buildings to which it is adapted, we may note the following, some of which have already been mentioned: A quick and efficient removal of air from all parts of the heating system when steam is first turned on, resulting in a rapid circulation of steam throughout the entire system of pipes and radiators; the removal of condensation as fast as it is formed, preventing water hammer and permitting the use of dry returns, which is often a matter of much convenience. It makes possible carrying a pressure on the heating system below that of the atmosphere, and so removes a certain amount of back pressure from the engines when operated in connection with a power plant. It also permits a certain range of general temperature regulation by throttling the supply of live steam through the reducing valve, or individual regulation by the use of graduated valves on the supply ends of the radiators. It does away with the necessity of air valves, but substitutes in their stead automatic or thermostatic return valves, which require a certain amount of care and more or less frequent inspection.

Vapor Heating

THE "vapor" system of heating, so called, varies from the vacuum system, in that the pressure is usually practically the same throughout the boiler, radiators, and both supply and return piping. Systems of this kind are usually confined to dwellings and similar buildings, and are not in general use in connection with exhaust steam heating. The chief advantage of the vapor system is that it allows of a certain amount of temperature regulation by varying the pressure and temperature of the steam within the radiators.

In operation, the steam pressure is first raised slightly above that of the atmosphere, and the air driven out of the system through one or more special air valves, which allow it to flow out of the system under pressure, but do not allow it to enter again after the pressure drops. When the system has once been cleaned of air, the steam pressure in the boiler may be lowered to a point considerably below that of the atmosphere, and thus circulated at a lower temperature. By varying the pressure in this way a considerable variation of temperature in the radiators may be obtained.

Types of Vacuum Systems

THERE are 2 general types of vacuum systems in use in large buildings. The first of these, shown in Fig. 1, has the supply and return connections provided with shutoff valves the same as the ordinary pressure system, and the condensation flows to the receiving tank by gravity. The vacuum feature in this system consists in attaching a suction line to the automatic air valves, as indicated in the cut. This arrangement quickly clears the radiators of air and thus produces a rapid circulation of steam through them. A pressure below the atmosphere may be maintained by admitting live steam through a reducing valve, as already described, and returning the condensation to a closed receiver carrying the same pressure as the supply system. From here the return is fed into the boilers by means of a pump in the usual manner. This is the principle employed in the Paul system. The vacuum in the air line may be produced by a pump if desired, but it is more common to employ an ejector.

The principle of operation where a suction is attached to the return ends of the radiators is shown in Fig. 2. Steam is supplied to the radiators at a low pressure through a reducing valve; graduated hand valves, or pneumatic shut-off valves, are placed on the supply ends of the radiators, and thermostatic, or other forms of automatic valves, which open only in the presence of air or water, provided upon the return ends.

The main return pipe is connected with a vacuum pump which discharges the moisture of air and water into a separating tank.

Here they are separated, the air passing off through the vent, and the water flowing into the receiving tank by gravity, from which it is pumped back to the boiler in the usual manner.

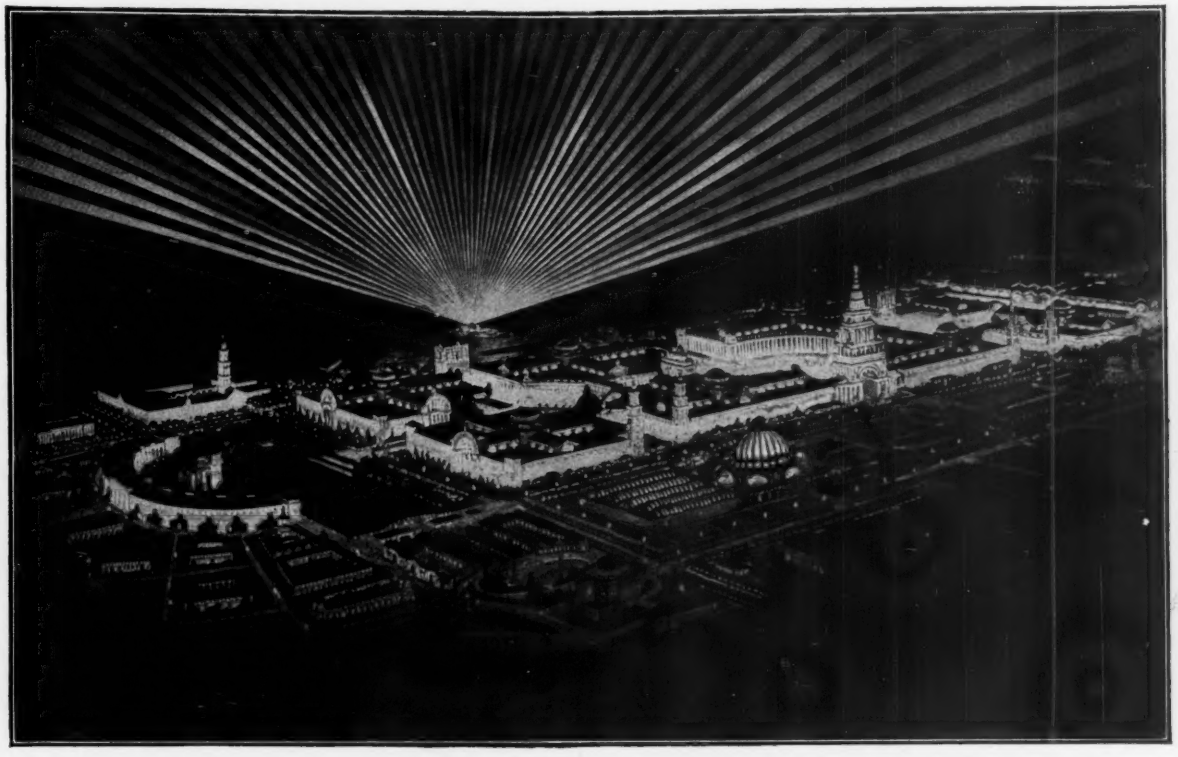
The automatic valves, marked "T" in the cut, are similar in principle to an ordinary automatic air valve, opening to admit the passage of air and water and closing in the presence of steam. The engine room piping for the Warren Webster system of vacuum heating, which operates on this general principle, is shown in Fig. 3, and is fully explained by the notes on the drawing.

Details of some of the apparatus used in vacuum heating will be given in a following article.

ILLUMINATION FOR PANAMA-PACIFIC EXPOSITION

THE Panama Canal will be officially opened by the government on January 1, 1915. To fittingly celebrate this event the Panama-Pacific Exposition was planned which is scheduled to open February 20 and continue until December 4, 1915.

M. D'Arcy Ryan, director of the illuminating laboratory of the General Electric Co., was appointed to undertake the decorating and illuminating of the exposition. Due to the remarkable advance in the science and art of electrical engineering, Mr. Ryan claims that in 1915 there will not be a single piece of lighting that has ever been used before; everything will be new.



LIGHTING OF THE PANAMA-PACIFIC EXPOSITION

(Copyright, 1912, by Panama-Pacific International Exposition Co. and General Electric Co.)

The exposition grounds contain 625 acres in the Harbor View section, forming a natural amphitheater overlooking San Francisco Bay and the Golden Gate entrance from the Pacific Ocean. The grounds include part of the U. S. military reservation, the Presidio on one end and Fort Mason on the other. They are within the city limits of San Francisco and within 2 miles of the heart of the business section.

The plan of the buildings is as unique as the harmonious decorative and light scheme. There will be no assemblage of individual palaces, separated by huge intervening areas as heretofore. Eight of the main exhibit palaces will be grouped around the 3 principal courts in stupendous oriental-bazaar fashion as found at Constantinople, Damascus or Cairo. This enormous structure will equal in height the average 6-story city building and will cover an area of over 4000 ft. long by 1200 ft. wide. It will occupy over 100 acres and will be spread out along the waters of the bay. The various exhibitions of Education, Fine Arts, Administration, Varied Industries, Manufacture, Liberal Arts, Machinery, Mining, Transportation and

Agriculture are approached consecutively, like the rooms of a single colossal palace, and will be identified chiefly by their interior equipment, as one passes through great corridors 40 ft. wide and 100 ft. high with exhibits on the right and left. To the east of this main structure are the amusement concessions, while to the west lies the small city of Foreign Government pavilion and States Buildings.

The offiical colors of the exposition are vermilion, burnt orange, and a very rich oriental blue. The ground tone will be about the color of travertine stone, intensified by lighting to an ivory yellow which, from a distance, will appear almost white. Pillars and colonades will be ivory toned and walls back of them will be Pompeian red. All roofs of buildings will be covered a reddish-pink. Statuary, particularly in groups, will be highly colored, rivalling the beauty of the highly colored lily pools.

The central block of the grounds is divided into 3 magnificent courts, in the center being the Grand Court of Honor, or the Court of the Sun and Stars. This is 900 by 500 ft., and will be dominated by a great tower rising 400 ft. in the air on the Administration Building and over the main entrance. This tower will be studded with 50,000 jewels, diamonds, topazes, rubies, and sapphires, which will sparkle at night in the powerful rays directed from batteries of search-lights. The size and cuts of the jewels are so entirely different from anything previously produced, that illuminating engineers were obliged to figure and measure the index of refraction of the glass for the various effects and distances. Similar jewels will be added wherever they can add to the beauty of a surface or sculptured form. They will then be suspended on delicate springs so that the least vibration will keep them in motion and set them flashing.

In the center of the Grand Court of Honor will be a sunken garden, 5 ft. below the court level. This will be rich with palms, shrubs and flowers and will embody 2 great fountains. At night the court will be illuminated from the fountains within each of which will be concealed 72 luminous arc lamps, which will flood the court with a soft diffused white light.

Extending entirely around the court will be a colonade, with columns 50 ft. high, surmounted by figures emblematic of the stars. These figures, of which there will be 110, standing 14 ft. high, will be crowned by stars measuring 4 ft. across. The stars will be studded with 10,000 jewels and these will be lighted from the base of the figure on the opposite side of the court in each case.

Throughout the grounds ornamental enclosed, flaming arcs will be used, fitted with globes, thereby reducing the glaring illumination. In all courts, special lamps and reflectors will be concealed in the fluting of the columns.

One striking feature will be the waterless electric fountains. Steam and smoke will replace the water and the rays of the large scintillator will be directed on them. A large locomotive, mounted on a turntable, will belch forth great columns of steam and smoke through which the various colored rays will play. If present experiments prove successful, thousands of gigantic soap-bubbles will be released from a large blower and will float into the air illuminated by powerful colored rays.

On festive nights, large numbers of cloth balls will be sent soaring into the air and tinted with ever changing color combinations of light.

The source of the powerful rays will be from a mammoth electric scintillator of 4,000,000,000 c.p. anchored on barges in the bay about 500 yd. from shore. It will consist of a battery of search lights, 48 in number, representing the States, with 36-in. parabolic reflectors. Sixty men will be required to operate the lights and on clear nights the lights will be visible in cities 50 to 60 miles distant.

TRIGONOMETRY AND THE SLIDE RULE

Figuring the Right Triangle and Some Cases Where it Comes Handy

IN work on right-angled triangles it is frequently necessary to figure the sides; knowing either the value of any 2 sides, or of one side and one of the acute angles.

Suppose it is required to figure side c, of Fig. 1, if sides a and b are given:

Two Sides Given to Find the Third

FOR a right-angled triangle, 2 sides given in each case, the following equations show the relations:

$c^2 = a^2 + b^2$; from which follows: $c = \sqrt{a^2+b^2}$ (1)

If side a is required and the other sides known:

$a^2 = c^2 - b^2$; from which follows: $a = \sqrt{c^2-b^2}$ (2)

If side b is unknown and the other sides given:

$b^2 = c^2 - a^2$; from which follows: $b = \sqrt{c^2-a^2}$ (3)

Let us assume, for example, that in Fig. 1, side a = 1 ft., side b = 3½ in.

From equation (1), $c = \sqrt{12^2 + 3\frac{1}{2}^2}$; from which follows: $c = \sqrt{144 + 12.25} = \sqrt{156.25}$; then c = 12.5 in.

Examples for practice: Side b = 6 in.; side c = 1 ft. 3 in. Required to find side a. Answer, 13.7 in.

Side c = 13½ in.; side a = 2 ft. Find side b. Answer, 19.85 in.

Side a = 6 in.; side b = 21 in. Find side c. Answer, 21.8 in.

These problems can be easily done with the slide rule. Take, for example, the problem worked out above:

Place the runner of the rule with the hair-line directly over the first Fig. 2 on scale D, or at 12, and the square of 12 will be found directly above it on

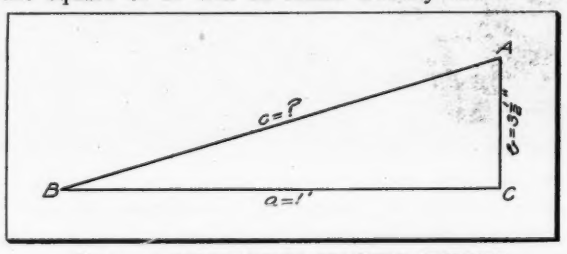


FIG. 1. A RIGHT-ANGLED TRIANGLE PROBLEM

scale A, or 144. Do likewise for the square of 3.5, placing the hair-line over 35, on D, the square = 12.25, being found directly above on scale A. The addition, as indicated in the problem, is then made. For the final step of extracting the square root of 156.25, since 156 has an odd number of places in it, place the

hair line on 15625 on left-hand scale A. Directly below this on scale D is now found 12.5, the required answer.

One Side and an Angle Known

IN the solution of right-angled triangles, if only one side and one angle is known—besides the right angle—the problem becomes different. For example, angle A and side a known, let it be required to find sides b and c in Fig. 1.

In the trigonometric functions published in the June 15 issue, there are various relations involving the known angle A and side a, with the unknown side b or c.

To determine side c, we can use,

$$\text{Sin } A = \frac{a}{c}; \text{ then } c = \frac{a}{\sin A}$$

Knowing the value of angle A, its sine can be found from the Practical Tables; and with side a known, c is easily determined. For example:

Angle A = 30 deg., side a = 2 in.

Sin 30 deg. = 0.5.

$$\text{Then side } c = \frac{2}{0.5} = 4 \text{ in.}$$

In finding side b, the following relation can be used:

$$\text{Tan } A = \frac{a}{b}; \text{ then } b = \frac{a}{\tan A} \text{ or } \frac{2}{\tan 30 \text{ deg.}}$$

From the Practical Tables, tan 30 deg. = 0.5774.

$$\text{Then } b = \frac{2}{0.5774} = 3.46 \text{ in.}$$

Examples for practice:

Angle B = 60 deg., side a = 2 in. Find sides b and c. Answer, b = 3.464 in., c = 4 in.

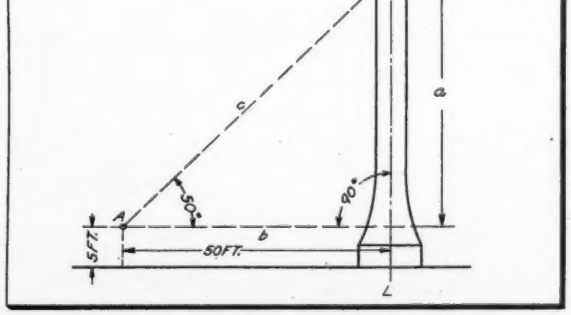


FIG. 2. FIGURING THE HEIGHT OF A STACK

Side c = 4 in., angle A = 65 deg. 40 min. Find sides a and b. Answer, a = 3.6448 in., b = 1.648 in.

Side b = 6 in., angle B = 43 deg. 20 min. Find sides a and c. Answer, a = 6.3594 in., c = 8.742 in.

Everyday Problems

TRIGONOMETRY, as applied to practical applications, may be illustrated in the following examples:

Let it be required to figure the height of a steel stack or tower.

Referring to Fig. 2, angle A can be found by means of a common machinist's protractor, one side being level, and thus perpendicular to the imaginary center line C L of the stack. In this case it is found to read 50 deg.

Suppose the sighting point were 50 ft. from the center of the stack and, for convenience, 5 ft. above the level of the base.

From trigonometric relations involving angle A, side b and unknown side a:

$$\text{Tan } A = \frac{a}{b}; \text{ then } a = b \times \tan A.$$

From the Practical Tables, tan 50 deg. = 1.1918.

Then a = 50 × 1.1918 = 59.6 ft.

Total height = 59.6 + 5 = 64.6 ft.

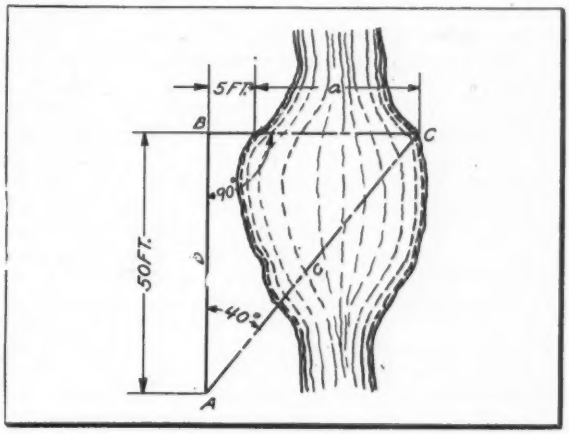


FIG. 3. MEASURING A HORIZONTAL DISTANCE WHICH IS INACCESSIBLE

If the distance A C or c were required, as for example the length of a guy wire, the problem could be solved in following manner:

$$\text{Cos. of 50 deg.} = \frac{b}{c}; \text{ then } c = \frac{b}{\text{Cosine 50 deg.}}$$

From the Practical Tables Cos. 50 deg = 0.6428.

$$\text{Then } c = \frac{50}{0.6428} = 77.8 \text{ ft.}$$

Suppose it is required to find the distance across a waterfall or rapids:

A convenient mark is chosen at C on the opposite bank, on a level with the sighting point of the transit or the protractor—whichever is to be used for the measurement of the necessary angle A—and B is established at 5 ft. back from the bank.

A line A B is measured off a convenient distance—say 50 ft.—at right angles with the line B C whose distance is required.

Suppose the angle A is found to be 40 deg.

Then from trigonometric relations involving side BC, side b and angle A,

$$\text{Tan } A = \frac{BC}{b}; \text{ then } BC = b \times \tan A.$$

From the Practical Tables, tan 40 deg. = 0.8391.

Then BC = 50 × 0.8391 = 41.95 ft.

The actual distance across the stream, from shore to shore, is: 41.95 — 5 = 36.95 ft.

Slide Rule Methods

IF the trigonometric tables of angles are not available or the slide rule is to be used exclusively, the above problems can be solved as follows:

In the river problem side BC = 50 × tan 40 deg. Reverse the slide of the rule, bringing the ends into agreement. Place the hair-line over the 40 mark on

the T scale. Directly below this, on the D scale, is the number 0.839, the value of tangent 40 deg., this being less than 1 when the angle is less than 45 deg., as explained in the June 15 issue. Now reverse the slide once more without shifting runner and bring number 1 of scale C directly in line with the hair-line. Now multiplying tan 40 deg. (found to be 0.839) $\times$ 50 ft. in the usual way, the answer will be found on scale D, under figure 5 of scale C = 41.9 +.

In the stack problem, the operation is somewhat different, due to the angle being greater than 45 deg.

As explained in the June 15 issue of the Practical Engineer, the tangent value for angles greater than 45 deg. is found by counting backwards from 45 until the figure agrees with the number that the required angle differs from 90 deg. In our example this is 90 — 50 = 40.

Placing the 40 on the T scale under the cross-line on the back of the rule, the value of tan 50 will be found on the D scale, under 1 of scale C = 0.192.

Having found the value of tan 50 deg., as just explained, it is only necessary to multiply this by 50, which can be done in the regular way, by placing runner hair line over 50 of scale C and finding the answer on scale D, directly underneath. This is found to be a = 59.6 which agrees with the work as done with the Practical Tables.

In the calculation of the guy wire length, proceed as follows:

$$c = \frac{a}{\text{Sin } 50 \text{ deg.}}$$

Reverse the sliding scale of the rule, bringing the ends into agreement.

The value of sin 50 deg. can now be read directly, on scale A directly above the 50 mark of scale S and = 0.766. Now it is only necessary to divide a, or 50 ft., by the value just found. Reverse the slide to the usual position; place 766 of scale C over 59.6 on scale D; the answer is then found under figure 1 of scale C. This equals 77.8 ft., which agrees with the answer as solved with the Practical Tables.

SPARK ADVANCE AND GAS MIXTURE

Effects of Changing Proportions of Air to Gas and the Lead of the Spark on Gas Engine Action

By J. E. Miller

THE following cards were taken by the writer and show exactly what happens inside the cylinder for various mixtures and spark positions. A horizontal 4-cycle engine was used, rated at 36 hp. at 220 r.p.m., the bore and stroke being 11¼ and 18 in. respectively. The engine was operated on city gas by the hit and miss principle and ignition was obtained by the hammerbreak method, a low tension coil and 4 dry cells being used to supply current for 2 platinum points which were rubbed past each other, thus causing the spark.

The following explanation applies to all the cards: The figures on the left indicate the pounds pressure above atmospheric at various important positions of the piston. The lower line is the atmospheric pressure line. Below this are given the number of degrees the crank has turned past dead center when the maximum pressure is obtained inside the cylinder. To the right is given the amount the gas cock is open. This does not give the proportion of gas in the mixture, but indicates relatively the amount of gas used. The lead of the spark I think is self-explanatory. All 4 of these cards show about 68 or 70 lb. compression and about 7 lb. back pressure during the exhaust period, both of these figures being reasonable for this type of engine.

Card No. 1 shows the effect of a weak mixture and small lead. The point of greatest pressure does not come until the crank is at an angle of 62 deg. from dead center. As 150 lb. maximum is a very low figure for this particular engine, it is seen that a stronger mixture would raise it.

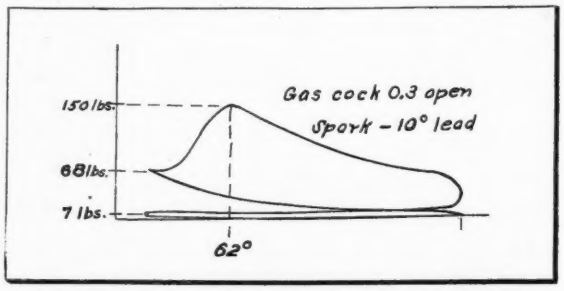


FIG. 1. EFFECT OF WEAK MIXTURE ON GAS ENGINE CARD

In Card No. 2 the spark advance remains unchanged, but the gas cock is now on the 0.7 mark. The maximum pressure has been raised considerably, but it readily appears that by further advancing the spark it can be increased and made to come at an earlier part of the stroke, thereby increasing the area of the card and giving more power to the engine.

Card No. 3 shows the result of advancing the spark to 28 deg. with the same mixture as Card No. 2. We are now getting about as much power from the engine as it is possible to obtain. Therefore, this general shape of card is representative of this type of engine. Perhaps it might be slightly improved by cutting down the spark advance a few degrees so that the maximum pressure would come at the point x marked

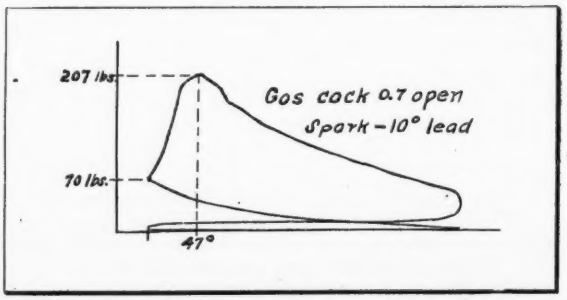


FIG. 2. GAIN OF POWER OVER FIG. 1 FROM STRONGER MIXTURE

on the card. This would take away some mechanical strain and in a few cases make the engine run easier and smoother because the piston would be traveling at a higher speed at the time of maximum pressure.

The maximum pressure of 310 lb. is rather high for most engines, this being dependent upon the piston clearance that the designer chooses. By following the lines on the bottom of the card, it is seen that an explosion took place at 8 strokes of the engine.

By taking two cards, one over the other on the same paper, card No. 4 plainly shows the effect of cutting down the fuel supply, the spark position remaining the same. The inner curve tells us that the mix-

ture is weak and does not readily burn. The maximum pressure is low for this engine and comes at a late period in the stroke. By comparing the inner curve of card No. 4 with No. 1, and the outer curve with No. 2, the reader can readily see how a few degrees difference in spark advance affects the power of the engine. In some cases it is difficult to tell which the engine needs, a stronger mixture or a greater spark advance.

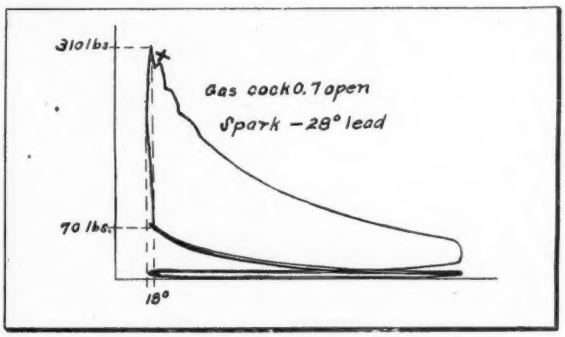


FIG. 3. GAIN FROM ADVANCED SPARK

It is not only necessary to know when you are getting a good card from your engine, but sometimes of importance to ascertain the actual horsepower furnished.

In the regular formula for the horsepower of an engine, N is the number of working strokes or explosions per minute.

This particular engine being governed by the "hit and miss" method, its firing cycle would be somewhat as follows:

Light load.....Fire 1—miss 5—fire 1—miss 5—etc.
Medium load....{ Fire 3—miss 2—fire 1—miss 1—etc.
Fire 6—miss 2—fire 3—miss 2—etc.
Full load.....Fire 6—miss 2—fire 5—miss 1—etc.

The above is not actual for this engine, but simply illustrates a few common firing cycles.

Enough cards should be taken to cover a complete firing cycle and the average mean effective pressure of all the cards should be used.

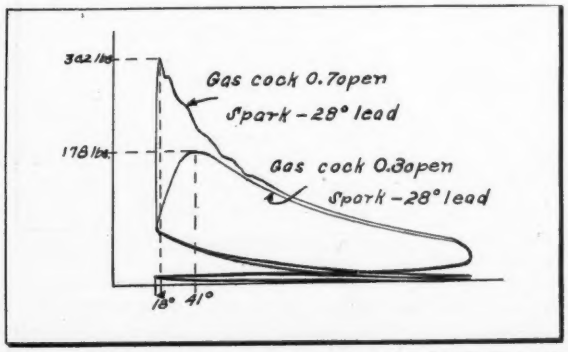


FIG. 4. COMPARISON OF WEAK AND RICH MIXTURE WITH ADVANCED SPARK

The most common way of finding the m.e.p. of a card consists in dividing the cards by vertical lines into about 15 spaces of equal width. Then measure the average height or pressure of each space, add them up and divide by the number of spaces.

In all cases it is necessary to apply a few corrections. For work that must be absolutely correct, a card should be taken with a 20 or 50 spring so that accurate measurements at low pressure may be taken. It will be noticed that the pressure on the exhaust stroke is above atmospheric, while that on the filling stroke is below the line. The average difference in pressure between these lines should be subtracted from the m.e.p.

It will also be seen from card No. 3 that there is a difference of 3 or 4 lb. between the compression and expansion lines on a miss card and that it amounts to considerable if many misses occur between fires. This means difference in pressure should also be subtracted from the m.e.p.

On a 2-cycle engine an indicator having a light spring should be attached to the crank-case, in order to measure the power consumed by drawing in and slightly compressing the charge in the crank-case. This should be subtracted from the work done in the cylinder.

The other symbols in the formula are sufficiently plain so that with the instruction given, accurate cards may be taken.

AN INTERESTING DEVELOPMENT in the generation and transmission of electrical energy is recorded by the Engineering Record as being located in central Nova Scotia, in the Chignecto of the bituminous mining district, about 8 miles from Amherst. The station has about 1000 kw. capacity, located at the mouth of the mine and transmits the current generated to Amherst and to the mining district on the bay of Fundy with intermediate service at various towns. Transmission is at 11,000 volts, the most remote substation being 15 miles from the power house.

The fuel used is screenings, which are fired without any attempt at separating the dirt or slate by a conveyor leading to a coal pocket in the boiler room. The boiler equipment consists of 8 150-hp. return-tubular boilers, with underfeed mechanical stokers. Both natural and forced draft are used, the latter being furnished by either of 2 sets of blowers, which can give 5 in. draft in the ash pit when all the boilers are in operation. Because of the poor quality of the fuel, the grate surface is made larger than usual, being 49 sq. ft. for each boiler.

Steam is furnished from this boiler plant for the hoisting service at the mine, and also for the electrical generating plant. Allowing for the steam used in the mine plant, the fuel consumption is about 6.5 lb. per kilowatt-hour at the busbars, the fuel containing 20 per cent ash. Vertical cross compound condensing engines are used, the cooling water which is drawn from a small creek nearby, being economized by a cooling tower.

If it were not for this plant, some 30 per cent of the mine output would be worthless, as it would not pay for transporting and selling, so that the saving is much greater than would be the case if good quality coal were used. Because of the variety of load supplied, the plant is at present working at a load factor of about 73 per cent on a 24-hr. basis. The poor fuel requires considerable increase in labor, and it is necessary to clean the fires every 2 hr. but since the fuel itself is practically valueless, the whole transmission becomes profitable and a good example of the utilizing of by-product that otherwise would be wasted.

A MAN'S TRUE GREATNESS lies in the consciousness of an honest purpose in life, founded on a just estimate of himself and everything else, on frequent self-examination, and a steady obedience to the rule which he knows to be right—without troubling himself about what others may think or say or whether they do or do not do that which he thinks and says and does.

RUNNING OIL ENGINES ON THE MANCHAUG RIVER

Difficulties Encountered Operating an Engine While a Building is Being Erected Around it

By C. E. Corning

THE Union Watch Co. on the banks of the Manchaug River set out to build a power plant and install oil engines to drive the generators. Instead of building the power house first and installing the machinery afterwards, they put up the engines first and then erected a high posted shack which resembled the head house of a coal mine. First one engine was set up and roofed over and then preparations were made to put in the other which had to be moved from the other end of the yard.

About this time there were several characters that are prominent in this story. First, the new master mechanic of the company, Mr. Curley, who knew nothing about oil engines; Mr. Gooch, at the time operating the oil plant, who knew it all and then some; Mr. Gale, of the company's largest steam plant, who desired to have control of all of the power plants and Mr. Ferguson who was qualified by experience to operate either steam or oil engines and who was also new to the establishment. This last person was hired to have charge of the new central power station when it should be completed; it is interesting to see what efforts were made to throw him at first and how finally he came out triumphantly and gained the good opinion of the owners of the works.

The intention was to have Ferguson take immediate charge of the oil plant and Gooch act as his assistant; but the latter refused to do this and thus placed the master mechanic in a quandary, for he feared to allow Ferguson to take over the control as Gooch had said that he did not think that he was capable of handling it. Therefore, Ferguson was placed in the plant to do part of the work, but with no authority for the present.

Some men would have rebelled at once against such treatment, but as Ferguson was desirous of helping out all that he could he talked the situation over in a fair manner with Gooch and agreed to do everything to make things agreeable until such time as Mr. Curley should decide what to do.

Relieving the Air Compressor

THE undecided manner of Mr. Curley was very discouraging to Ferguson and from its effects he never fully recovered; but he went to work doing his best on whatever came his way and watched things happen. One day the air compressor gave trouble with its valves so that a shut-down was necessary. At another time one of the piston rods broke and while Gooch was sent up to run a smaller engine to help out until the compressor should be running again, he was quite surprised to see Ferguson go down and pull the piston out of another compressor and put in a new rod in much less time than he had expected. It was the purpose of Mr. Gale of the steam plant and Gooch to get control of the new power plant and what Gale lacked in information about the oil engines he expected Gooch to make up, so that they did everything they could to make it hard for Ferguson by concealed methods; their efforts, however, were of little avail.

The custom was to blow the excess air from the compressor out of the high pressure line and Ferguson said one day: "Gooch, why do you bleed the air from the high stage?" "Where else can you take it from?" said Gooch in a sulky manner.

"If I were doing it I should bleed from the first stage," replied Ferguson, and added, "this compressor is large enough for 2 6-cylinder engines and we are running but one, so to have the compressor use as little power as possible we should not attempt to compress as much air as 2 units would need."

"Well, how are you going to do any different?" broke in Gooch.

"I was coming to that," replied the other, "and it is very simple. First, we will assume that this engine requires 10 cu. ft. of air per minute at a pressure of 1000 lb. per square inch; now is it not going to take more power to compress twice that amount to that pressure?"

"I don't see why it does not take just as much power to raise the air up to the high pressure no matter what the volume is," answered Gooch.

"If that were the case a small compressor could do as much work as a large one in compressing to the same pressure, so if we only raise the volume of air necessary for this engine to 1000 lb. pressure we must save some of the power that we are using now and blowing off into the air. To do this we cannot prevent the full quantity of air from entering the first cylinder, where it is now raised to 55 lb. to 175 lb. in the second and to 1100 in the third. Now, suppose we bleed enough air from the first cylinder so that it will just keep the high pressure at 1100 lb. with the bleeder that you have been using closed and, as you see, the first cylinder gage shows 25 lb., the second, 100; thus we cannot be doing the work that we were before and still the engine has enough air."

But Gooch would not be convinced that there would be any saving, although the motor driving the compressor ran much cooler and at higher speed when bleeding out of the first stage. When Mr. Curley heard of it he soon came to the belief that there was a gain over the old method and he approved of it.

From that time it became apparent to Mr. Curley that Ferguson, however retiring he was, did not make any statement until he could back it up; as Gooch was just the opposite, he felt that he had erred in hesitating between these 2 men and as Ferguson had also operated one of his steam plants when men were out, he had still more reason to be satisfied with him.

After the new engineer had been there about 6 weeks Mr. Gooch felt that he was not sufficiently appreciated and his efforts to have Ferguson removed being unavailable, he was transferred to another department and thus that matter was settled.

Being in need of an assistant, Curley advised trying a young man by the name of Richards whom he had recently hired and who had had some experience with gas engines. This was done and Ferguson commenced to break in the new assistant.

Color of the Exhaust

ONE day as they stood looking at the exhaust pipe which was emitting a light blue smoke, Ferguson remarked upon it to Richards. "I have noticed it," said Richards, "and it is not much different from the exhaust from many gasoline engines." "True,"

replied the other, "with the Diesel engine, however, the exhaust should be clear from a very light load to an excessive overload and the system of combustion may be compared to an oil lamp. If we turn up the flame too high the small holes under the burner cannot supply air enough for perfect combustion, so that we have a black smoke given off which is nothing more than unburned carbon; also, if we turn the flame too low, while it does not often produce smoke, it gives off some odor. Thus, in these engines we see the same thing produced; for while the fuel pump can throw plenty of oil into the cylinders if the speed drops enough to cause it to do so, the cylinder will hold but a certain quantity of pure air which, when combined with the right amount of oil, will burn with smokeless combustion and if too great an amount of oil is injected, there must be some unburned carbon thrown off. If we have a very light load, say about 30 hp., there will be a more pronounced odor to the exhaust gases and they will have a light blue color."

"But there is a good load on the engine now," said Richards; "she is pulling about 200 kw. by the wattmeter and still we have the blue smoke.

"I have not looked into it very carefully," said Ferguson; "but I asked Gooch one day if he did not think that one of the fuel valves leaked. He said in his superior way, 'Oh no, for if they did, there would be movement of the instrument pointers on account of the leaky valve firing too soon.'

"Now, he would be right if it leaked too much, but it could leak some and still not enough to cause a premature burning. If you will look over all of the cylinders you will see that around the exhaust valve of No. 1 there is blue smoke coming out; and if you should listen some time when the injection air is turned on just before starting whenever the admission valve may be open, you will hear a hissing sound which can come from no other place than the fuel valve opening, so if we should take that valve out I am certain that we would find a leak there."

"But just why does that cause the blue smoke?" asked the assistant.

"Because, while the piston is making the exhaust stroke, that oil is spraying on the hot parts which do not burn it with a flame but simply smoke, just as a small quanitity of kerosene would if you should throw it upon a piece of iron that was heated to about 300 deg., so this smoke is thrown off and causes that smoky exhaust," answered the chief. In a short time Ferguson pulled out the valve and on the nickel steel point was a very small v-shaped cut which at 1000 lb. pressure would admit quite a stream of oil. After a new valve was put in and ground to a tight seat the blue smoke disappeared.

Timing the Fuel Valves

FERGUSON did not know how the fuel valves were timed to admit the fuel oil and as there had not been enough load on the engine to make much difference up to this time, he did not look them over; but one day when the engine had nearly full load on he saw puffs of black smoke thrown off at the exhaust and he took the first opportunity to set the valves.

"There are no marks on this flywheel rim for the top centers," said Ferguson one day, "and before we can set the fuel valves we must put on a tram with a pointer that will always be permanent. When we have this, then we will put all of the cranks so they will be on the top center and make a mark on the rim to correspond so that we can always use it in the future."

He decided to fasten the tram pointer to the frame of the generator, as that was the most convenient place and since there would soon be 2 units to run he had a machinist make a tram that could be used on both wheels. He had it made of a piece of 1 by ¼-in. iron and held it by a small cap screw and a dowel pin so that it was easy to change it from one unit to the other.

One day when all of the crank-case doors were off he told Richards to take Mike, the oiler, and his helpers and turn each crank to the top center and, holding a level upon them until they were perpendicular, mark the rim of the wheel and as 2 cranks were on the center at once he had put 3 marks and put on one, the numbers 1 and 4, and on the others, 2 and 5 and 3 and 6.

Then he said to Richards, "Turn the engine so that No. 1 crank will be approaching the firing point say about 36 in. from the right mark on the wheel. Now close all of the oil by-pass valves on 1, 2, and 3 cylinders and turn on about 800 lb. of air and while I climb up on the platform and listen at the fuel valve you may turn the engine slowly with the bar until I tell you to stop."

They did as directed and when the tram pointed to a spot about 7½ in. from the center mark, Ferguson shouted for them to stop. As that was a fair lead he decided to leave it that way and go on to the next cylinder, which was No. 6, and after going through the same operation with regard to it, this valve opened at a point about 5 in. from the center mark on the wheel rim; as that was too late for it to open, Ferguson had them turn the engine back and he then lengthened the valve rod so the roller would engage the toe of the cam sooner and thus, when tried again, the valve opened at the required time. They likewise went over the remaining fuel valves and found none with a greater lead than 7½ in., so he concluded that that was the earliest that had been given when the engine had been set up.

When this was finished Ferguson gave Richards some instruction as follows: "There are 2 ways to change the lead of the fuel valves— the way we have just done it or by a far more difficult method of setting the toes on the cams ahead. If you look at the fuel cams you will see that they are round for nearly all of the circumference and that the raised part that opens the valve is set into the main piece and fastened by screws. You will also observe that the holes are in the form of slots so that the toe may be moved ahead; thus, to increase the fuel valve lead, we can grind off some of the end of the toe and push it ahead and put something back of it to hold if the screws cannot do it.

By doing it this way you get an earlier admission and an earlier cutoff than by lengthening the valve rods, for by doing the latter way the roller commences to open before it is at the highest point of the cam and also closes gradually; while, if the toe is set ahead and the length of the rod is unchanged, the roller simply rides on the point of the cam and as soon as the point has passed it quickly drops back into its lowest position so that the valve gets an early cutoff as well as an early opening. In the case of a gas being admitted, the earlier cutoff would not give as much power; but, since the amount of liquid fuel is so small, the difference in the fuel valve opening is not of any account." (To be continued.)

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

THE USE OF CARBON BRUSHES

IN the course of a report of electrical apparatus, Mr. L. L. Elden, before the National Electric Light Ass'n., makes the following statement in regard to carbon brushes.

The hard carbon brush is usually selected because of its good wearing qualities and the good effect on the commutator. No initial lubrication is necessary, but the operating engineer will usually deem it wise to use some lubricant on the commutator. This should not be applied carelessly or too freely or the brushes will become gummed and stick in the holders, causing sparking and pitting of both brush and commutator surfaces. The usual current density allowed for such a brush is 35 amp. per square inch of cross section at normal speed, and it is customary to use the hard brush on all slow and moderate speed machines such as direct connected engine driven generators at all voltages, slow speed turbines, and in connection with graphite brushes, on motor generator sets above 500 kw. at 300 volts or more. For such sets it is undesirable to operate with grooved commutators, and the graphite brush has not sufficient abrasive material to keep the mica in the commutator worn down uniformly with the copper. The usual proportion is ⅔ hard carbon to ⅓ graphite brushes.

For higher voltage commutators it has been found necessary to use hard brushes frequently, because of the higher percentage of mica used in such commutators and the need of keping this mica worn down.

Treated Carbon Brushes

IN high speed machines where it is desired to have the brushes self-lubricating, the hard carbon brush is impregnated with oil or grease which provide enough lubrication until the commutator surface is in good operative condition, after which the commutator need only be wiped clean and the brushes and brush holders wiped occasionally. There is, however, with this type of brush, a great possibility of lack of uniformity in density, so that some brushes will absorb more lubricating agents than others and may bring about the condition mentioned for hard carbon brushes where too great a quantity of lubricant is used. To overcome this condition, and also to eliminate the necessity of having to use part graphite and part carbon brushes to give the required wear on the mica, a brush made of a mixture of carbon and graphite is frequently used. The treated carbon brush is used on railway and mill type motors, motor generator sets up to 500 kw. and above 300 volts, and up to 150 kw. below 300 volts. Current density allowable is 35 amp. per square inch as before.

Graphite Brushes

THESE are used where a higher density of current is desired, namely 50 amp. per sq. in., and they have excellent lubricating qualities with low coefficient of friction and contact resistance as compared with the carbon brush. Such brushes are adapted to high speed commutators of low voltage machines in order to reduce the losses between commutator and brush, and at the same time keep the size of the commutator within reasonable limits. These brushes are used on motor generator sets below 300 volts and of more than 750 kw. capacity. They can be used on grooved commutators only, except where hard carbon brushes are used to wear down the mica. They are also used on direct-current turbo generators and high-speed field collector rings.

Copper Graphite Brushes

THESE are made of a combination of copper and graphite, the mixture having been originally developed for use on collector rings of rotary converters. They have low contact resistance and can safely carry current of 125 amp. per sq. in. A modification of these brushes is also used on commutators for very low voltage, direct-current machines such as for electrolytic work, for automobile generators and starting motors. This modified mixture can be used with current density of 100 amp. per sq. in.

Setting of Brushes

FOR commutators having a rim speed of 3500 to 4000 ft. a minute, brush holders set at 15 deg. should be used with the brushes set leading for 450 r.p.m. or less and trailing for more than 450 r.p.m. Where commutators run at over 4000 ft. a minute surface speed, brushes should be set at from 30 to 37½ deg. leading, and in all cases where a mixture of brushes, that is, part carbon and part graphite are used, the brush angle should be 15 deg. and operated trailing.

DURING THE PAST YEAR progress has been made in the manufacture of the incandescent lamp, both in the developing of new types and the improvement of old ones. The rated specific consumption of regular lamps has been reduced about 0.15 watt per candlepower on the larger lamps by using chemicals which retard the blackening of the bulb. These improvements have also made it possible to employ smaller bulbs for a given watt rating, particularly in the case of 40 and 60-watt lamps. The most striking development is the use of a filament wound into a helical coil, which coil may be mounted in different ways on the supports or even itself wound into a coil in order to get a great concentration of light. This coil construction permits a great length of filament being put into small compass without appreciable leakage between turns and thus gives a lamp which can focus closely as is required for stereopticons, projectors and head lights. The coiled filament may also be placed in a tubular bulb to make a show case lamp, consisting of a single straight section carried through the middle of the bulb with return circuit through a heavy wire support.

NEW POWERFUL ELECTRIC LOCOMOTIVES

High Speed Type. Represent Signal Advancement in Electric Locomotive Design. Ten Will Be Placed in Service in New York Central Terminal

TEN passenger electric locomotives are to be placed in commission by the New York Central & Hudson River R. R. Co., out of New York City. An exhaustive series of tests and trial runs of an experimental locomotive of this type was recently made on the Harlem Division. This locomotive was immediately put in service on the electrified section of the New York Terminal and a contract was awarded the General Electric Co. for 9 additional locomotives of the same design, which are now under construction.

The electric locomotives in service in the terminal previous to the introduction of the new engine weigh approximately 115 tons. While the new locomotives are considerably lighter, weighing 100 tons, they are much more powerful, are provided with ample forced air ventilation and designed with a view to continuous high-speed service. All the 100-ton weight is carried on motor-driven axles, while the former locomotives have but 70 tons weight on the driving wheels.

A still greater separation of the fixed wheel base and the guiding trucks lengthened the machine so as to necessitate constructing the running gear in 2 halves with a spring-connected articulated joint between the frames.

At the present time the New York Central & Hudson River R. R. Co. is operating 47 electric locomotives in the New York Terminal service. Of these, 35 were built in 1906 and 12 in 1908. They are all of the 115-ton 484 type and are each equipped with 4 GE-84 bipolar, gearless motors. The new electric locomotive adopted by the company is likewise a bipolar gearless design, but it is equipped with 8 GE-89 motors and is designated type 4444. Each motor is approximately ¾ the capacity of the GE-84 motor used on the previous engines, making the aggregate capacity of the motors on the locomotive approximately 50 per cent greater than before and affording approximately 25 per cent higher speed.

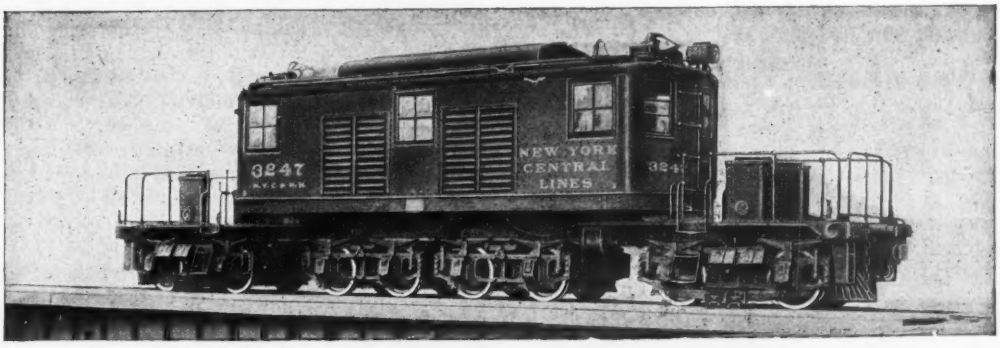


FIG. 1. SIDE VIEW OF NEW ELECTRIC LOCOMOTIVE

The new electric engines will exert sufficient tractive effort to haul a train weighing 1000 tons at 60 miles an hour. In regular service they have a capacity for developing 1400 hp. continuously and can develop as high as 5000 hp. for short periods.

Briefly, the history of the development of the New York Central latest type of 600-v. direct-current, passenger, high-speed electric locomotive recounts a notable achievement in designing skill. The original New York Central electric locomotives had guiding wheels in the form of a pony truck with 28,000 lb. on the axle. There were 4 driving wheels, each carrying the armature of a direct-current, bipolar, gearless motor. To improve the riding qualities of this pioneer express electric locomotive, a guiding bogie truck having 2 axles was substituted for the pony truck. A further development in a subsequent type was to increase the distance between the guiding trucks and the rigid wheel base. The riding qualities were improved, but at a loss in the mechanical efficiency of the locomotive; for about 40 tons of surplus weight have been added and were being carried by the bogie trucks for the sole purpose of guiding the locomotive.

The addition of motors to the bogie trucks and the elimination of this ineffective weight was the next step, so that every pound of the locomotive weight would be instrumental in producing adhesion and tractive effort.

In general, the locomotive may be described as having an articulated frame with bogie guiding trucks at each end. The cab containing the engineer's compartment and that for the operating mechanism is swung between the 2 parts of the frame on the center pins. Each section is equipped with 2 2-axle trucks having a driving motor mounted on each axle. These cannot be distinguished as main driving or leading trucks, since all the axles are driving axles; but they are termed for clearness rigid trucks and swivel trucks respectively.

The rigid truck is built up of heavy steel castings, the side frames being of a truss pattern with heavy top and bottom members and pedestal tie bars. The end frames and center cross frames are steel castings securely bolted to the side frames and supporting the magnet poles. The magnetic circuit of each truck consists of the armatures mounted on the axles, the magnet pole carried on the end frames, the side frames and an additional magnet bar forming a path in parallel with the side frames. The whole weight of the truck is carried on semi-elliptic and coil springs resting on the journal boxes and equalizing together.

The main frame or backbone of the locomotive is a box girder built of 10-in. channels with ¼-in. top and bottom plates. It is approximately 10 in. deep by 36 in. in width and 22 ft. in length. The frame is bolted to the top member of the rigid truck, and extends for-

ward over the center plate of the leading truck and backward to the heavy hinge which connects the 2 halves of the frame. The main frame carries in its top plate the center pin which supports the weight of the operating cab. All these center pins are hollow and serve as air passages, the main box girder frame acting as a distributing reservoir for the air delivered from the blower in the upper cab through the upper center pins and conducting it to the 8 motors below.

The construction of the swivel or leading truck is similar to that of the rigid truck, except that it carries a center pin and is connected to the main frame through this center pin instead of being bolted rigidly to it.

This type of design affords a long flexible wheel base with 8 axles, but restricts the length of any rigid portion to not more than 6 ft. 6 in. All the axles are equipped with motors, but the magnetic circuit for each truck or pair of motors is self-contained and relates only to the 2 axles in that truck.

The cab, carried on the 2 center pins as stated, has its weight distributed between the 2 halves of the locomotive frame. It is the box type 35 ft. in length and 10 ft. wide. The interior is divided into 3 sections. A motorman's compartment is located at either end and contains the motorman's seat, controller, air brake, valves, bell and whistle rope handles, and such parts of the control apparatus as have to be within reach of the operating engineer. In the central section of the cab are the air compressors, blowers, contactors and rheostats, grouped so that they are conveniently accessible for inspection and repair, and separated from the direct reach or attention of the operating engineer. The advantage of this arrangement is that it removes from the sight of the engineer, running apparatus which might serve to distract his attention from the actual work of handling the locomotive and which can be inspected and attended to by his assistant. This general type of construction leaves a fairly long platform on either end of the locomotive. Access to the cab is obtained through doors opening onto the platform.

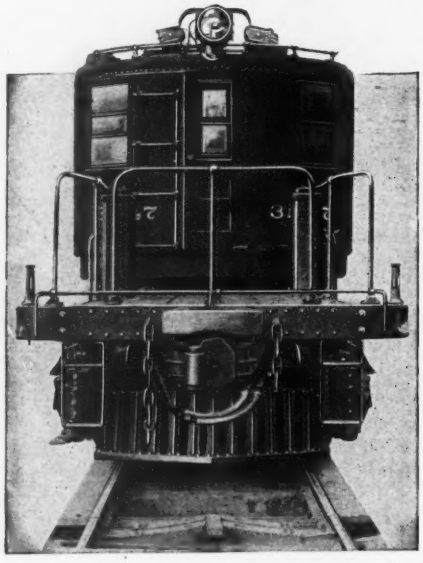


FIG. 2. FRONT OF NEW ELECTRIC LOCOMOTIVE

The principal data and important dimensions applying to the locomotive are the following:

Height with trolley running	15 ft. 1 in.
Length in side of knuckles	55 ft. 2 in.
Length over cab	33 ft.
Height over cab	12 ft. 8 in.
Height with trolley down	14 ft. 6 in.
Width over all	10 ft.
Total wheel base	45 ft. 7 in.
Rigid wheel base	5 ft. and 6 ft. 6 in.
Total weight	200,000 lb.
Weight per axle	25,000 lb.
Dead weight per axle	6,395 lb.

Taking up the specific features of the electrical equipment, the 8 GE-89 bipolar, gearless motors each have the armature mounted directly on the axle. The field poles are carried on the truck frame, which forms the magnetic circuit. There are 4 independent magnetic circuits in the locomotive corresponding to the 4 trucks. The magnetic flux path on each truck passes in series through the fields and armature of one motor, through the center transom and the fields and armature of the second motor to the end frame, and then returns to the starting point through the 2 side frames and a reinforcing magnet bar lying parallel with the frames.

The motor is practically enclosed, and the field coils are waterproofed and armored. Each field coil is wound in a brass shell, the windings being in 2 decks of flat ribbon copper, laid side by side. The outside turn is covered with insulation and an armor of sheet steel is clamped over it, filling the space between the sides of the shell in such a way as to protect the windings from mechanical injury. End shields are provided for each motor, which render it dust-tight and as nearly watertight as is possible in any motor designed with necessary outlets for forced ventilation.

Each motor at its one-hour rating has a capacity of 325 amp. on 600 v., or a continuous rating of 260 amp. on 600 v. under forced ventilation. For the complete equipment of 8 motors, this corresponds to a capacity of 13,500 lb. tractive effort at 54 miles an hour for the one-hour rating, and 10,000 lb. tractive effort at 60 miles an hour continuously.

Motors are electrically connected permanently in parallel in pairs, and in pairs can be connected in 3 combinations; viz., series, series-parallel and parallel. They are insulated for 1200 v., so that if at any future time it should be desired to operate the locomotive on 1200 v., the pairs of motors could be changed from parallel to series connections and the same speeds and control combinations obtained as on 600 v.

The control equipment on the locomotive is the Sprague-General Electric Type M and is designed to operate the 8 motors connected in the 3 combinations: series, series-parallel and parallel. The external regulating resistance, divided into 4 parts, is directly connected, each part to a pair of motors permanently grouped in parallel. The pairs of motors with their respective resistances are connected all in series on the first point of the controller. The resistance is varied through 8 points on the controller and finally short-circuited on the ninth or running point. The pairs are then operated similarly in series-parallel with all resistance cut out on the seventeenth point. Finally all of the pairs are connected in parallel with the twenty-fourth step a running point. This provides a control with 9 steps series, 8 steps series-parallel and 7 steps parallel.

The transition between series and series-parallel is effected without opening the motor-circuit, and there

is no appreciable reduction in tractive effort during the change. The smooth transition between points both rheostatic and transitional, permits motor operation close to the slipping point of the wheels. The locomotive weight on the drivers is so proportioned that the motors operate safely up to the slipping point, which serves as a limit to prevent overloading the motors. The transition between all 4 pairs of motors in series to series-parallel is accomplished by short-circuiting 2 of the pairs of motors during the instant of transfer. The transition between series-parallel and parallel is effected by means of the standard bridge method.

The motor cutout switches are connected so that any pair of motors may be cut out of circuit. The locomotive will operate when a pair of motors is cut out with 2 groupings of the motors, the first with 2 pairs of motors in series and the second with 3 pairs of motors in parallel.

The protection of the locomotive against short circuits is very complete. All main fuse boxes are of the copper ribbon type, fitted with hinged covers to facilitate fuse renewals. The box is provided with a very effective magnetic blowout, which is energized by the current passing through the fuse. The main fuse boxes are located as near as possible to the overhead trolley and to the third rail shoes in order to protect the wiring circuits near the source of supply. Each pair of motors is locally protected by a fuse box. The main switch is provided with a blowout so that heavy currents can be opened without damage.

An ammeter is located at each engineer's position and records the current in the circuit of one pair of motors. The ammeter and air gages are illuminated by a gage light connected in the headlight circuit, so that the headlight switch turns on simultaneously the headlight and the gage light at the same end of the locomotive.

The main motor rheostats are formed of cast-iron grids mounted in a frame and insulated in mica. The rheostat boxes are assembled in the monitor deck of the locomotive.

Current is collected by 8 underrunning third rail shoes, or by 2 overhead trolleys when on gaps in the third rail. The overhead trolleys are the pantograph type and are pneumatically operated. They can be put into service from either engineer's position by a foot-operated valve. The trolley is designed for intermittent use and is therefore arranged to be held in a raised position only while the valve is held open by the engineer's foot.

Headlights are the incandescent type with parabolic reflectors 16 in. in diameter. The interior illumination of the cab is provided by 10 incandescent lamps arranged in 2 circuits, 2 lamps being located in each engineer's cab and the balance in the central compartment. In each lamp circuit is a portable lamp with extension cord 25 ft. long. One lamp switch is located in each engineer's compartment, so that from either end of the locomotive the lamps can be controlled in that compartment, as well as half of the lamps in the central compartment.

Electric heaters are placed in the engineer's compartments. The heaters are a standard electric car type, fitted with especially heavy outside covers to protect them from the mechanical injuries to which they are exposed in locomotive service.

The blower set provided for ventilating the driving motors is located in the central compartment. The blower has a capacity of 24,000 cu. ft. of air a minute and is driven by a series wound motor of the railway type.

The air compressor is the CP-26 type. It is a 2-stage motor-driven compressor with a piston displacement of 100 cu. ft. of air a minute when pumping against a tank pressure of 135 lb. a square inch. The air is taken from the interior of the central compartment through a screen, which prevents the entrance of particles of dust. The compressed air in passing from the low-pressure to the high-pressure cylinder is conducted through radiating pipes under the platform of the main cab. This reduces the temperature of the air and allows condensation of moisture before entering the high-pressure cylinder. From the high-pressure cylinder it is delivered into a series of air reservoirs. There are 4 of these, each 16 in. by 90 in. They are located under the floor of the cab and connected in series, which affords a further opportunity for radiation and condensation.

Leach Type L double pneumatic sanders are provided. The sander valves are located within convenient reach of the engineer's seat, and valves and sand boxes are arranged for sanding the track in front of the leading wheels when running in either direction. The bells are fitted with Sampson automatic bell ringers. All wiring is drawn through conduits and is carefully protected from mechanical injury.

DRYING OUT THE DAYTON LIGHTING PLANTS

By George W. Christians

IT may seem rather odd to wash down the windings of a high voltage generator with a hose. Yet this was done with very good effect in the lighting plants of flooded Dayton. The receding waters, in addition to having thoroughly soaked all insulation, left behind a heavy layer of thick slimy mud. The most obvious and actually the most effective way to remove this mud was with a hose, and since the insulation could hardly get any wetter no harm was done by the water. The extent to which this mud clogged things up and the difficult places to which it gained entrance, are almost inconceivable.

An idea of the amount of material held in suspension by the water can be gained from the fact that a number of meter and Tirrel regulator cases on the switchboard at the Third Street plant, on which the high water mark could be seen about 6 in. from the bottom contained about half an inch of mud. Still there were exceptions. When the end bells were removed from the windings of a 6000-kw., 2200-volt, horizontal Westinghouse turbo-generator, the surfaces appeared dry and the parts of the windings immersed were still covered with the dust collected in ordinary operation, and appeared exactly like the parts which were untouched by the water. Yet this machine was under water nearly to the center of the shaft, and tests showed the insulation to be saturated. The probable cause for this absence of mud is the fact that the water in order to reach the winding had to come up through the basement which formed a depository chamber for the material in suspension, leaving the water clear when it reached the generator.

The water rose in the Third Street plant about 4 ft. above the engine room floor, so that the horizontal turbo-generators were wet to about the center of the shafts and were unbalanced; making it necessary to dry out the water not only for insulation purposes, but to restore their balance. In the case of a 100-kw. 2400 r.p.m. turbo-exciter, the drying out had to be

continued a considerable time after the machine was electrically fit for service in order to reduce vibration.

Another difficulty encountered in the Third Street plant was in getting steam. The draft flue from the boilers to the stack passes under the boiler floor, and, of course, was full of water. There were numerous leaks into this flue from the other parts of the basement, so that the entire building had to be pumped dry before steam to run the plant could be generated. The steam for these pumps was obtained from one boiler by cutting open the draft duct at the top and allowing the flue gases to escape through the roof.

At the Fourth Street plant, it was found necessary to dry the brush arc machines in an oven. The armatures contained much moisture which could not be reached by electrical heating of the windings, but which readily evaporated when evenly heated. Difficulty was also experienced in drying the field spools of these machines electrically. The difference of potential between the long layers of the cotton covered windings, when enough current to heat them was being passed, was sufficient to set up electrolysis between the layers, with a formation of copper salts, and eventually short-circuit them. These had to be stripped of their outer insulation and partially dried in the oven, then after a final heating electrically, and reinsulating, they were as good as new.

The work of restoring the underground and street lighting systems was hampered considerably by natural gas in manholes and cable ducts. The bases of the ornamental lamp posts were often found charged with an explosive mixture which would be ignited when the switch was opened. Great numbers of these ornamental posts were broken off and some even uprooted. An oxyacetylene blow torch was used to weld together the broken ones with very good results. After a coat of paint had been applied no one would know the post had been damaged.

ARMATURE WINDING PROBLEM

IN May 1 issue of Practical Engineer, I notice that J. A. D. asks for an opinion on his motor troubles. I don't know much about winding armatures by mail, but I believe that his troubles lie in his commutator connections.

He connects 1 and 2, and winds in slots 1 and 31. In case the brushes can be shifted, why, of course, it makes no difference how he connects, but most motors of that type have fixed brushes.

Since this is a bipolar series motor, then, if his fields run cool, it shows more current is circulating in armature coils than should be.

Area of field wire No. 2 = 66564 c. m.

Area of No. 8 wire = 16384 and 2 wires in parallel would be total area of 32768 c. m.

There are 2 No. 8 wires in parallel, since he has a closed winding, and this area certainly should stay cool if deeply wound fields do.

I think his coils commutate wrong and set up secondary surges in the coil short circuited by brushes as it passes the 2 bars to which are connected this coil.

The heavy surge of current thus set up by reversal in a strong field would tend to throw the coil out of slots and this tears his connections loose. This also chafed and grounded coils in the 4-hr. run.

Notice that the armature was burned out when he found it, hence even if wound exactly as before it might be wrong. Perhaps the previous man wound it wrong and gave it up.

If brushes can be moved, rewind and shift brushes till brush covers bars 1 and 2 attached to coil in slots 1 and 31 when it is between poles; i.e., with slots 1 to 31 in the open space between 2 poles.

If brushes are fixed, then wind and connect as follows: Wind in 1 and 31 as before, but carry ends of coil over to a pair of commutator segments so that when the coil spans the center of the open space between poles these segments will be under a brush.

If brush stands, say, in center of field pole, then end from slot 1 should go to bar 14 or 15 and end from slot 31 should go to 15 or 16. This commutates the coil while in neutral space and no pressure or voltage is acting to cause surge, as coil is cutting no lines of force.

I hope this will be of service and remedy the trouble. Chas. M. Green.

AN UNUSUAL WATER POWER STATION

IN connection with the construction on the White Salmon River, Washington, 75 miles east of Portland, Ore., of the 20,000-hp. hydroelectric development it was found necessary by the Stone & Webster Engineering Corp. to establish a temporary hydraulic plant for the purpose of furnishing power for carrying on the work incident to the building of the large plant.

A power flume 9 ft. 3 in. wide, built of wood, diverts water from the stream right through the new 125-ft. dam now in process of construction, carrying it to a point a few hundred feet below the dam where the small wooden power house has been established operating under a 13-ft. head of water. The prime mover is a 54-in. turbine built by S. Morgan Smith Co., York, Pa., capable of delivering at 13-ft. head a maximum of 300 hp. This is direct-connected to a generator rated at 150 kw. and 440 volts. Electric power is used for various purposes on the immediate work, including quarrying on top of the hill 400 ft. above the dam, operating concrete mixers, lighting, drilling, etc. It is also used at a point more than a mile down the river where the power house is being built, and to which point it is transmitted at 6600 volts. The depth of water in the flume is kept at 6 ft., by an ingenious arrangement of gates such that when the water falls below 6 ft., a bypass is closed and the flow is built up; when the water tends to exceed 6 ft. the bypass is opened wide and the excess water thrown into the bed of the stream between the big dam and the temporary power house.

This development, which is to be operated by the Northwestern Electric Co. of Portland, will have a head of 175 ft. and an impounded volume of 40 million cu. ft. of water. This water is gathered from a drainage area of 350 sq. mi. and is held back by a concrete dam of the solid gravity type, 470 ft. long with a 250-ft. spillway measuring 125 ft. high. Water will be carried from the dam to the power house by a wood stave pipe 5100 ft. long and 13 ft. 6 in. in diameter, emptying into a concrete forebay. From this point 2 pressure pipes 700 ft. long and 9 ft. in diameter will give the operating head of 175 ft. The purpose of the development is for lighting and power in Portland and vicinity.

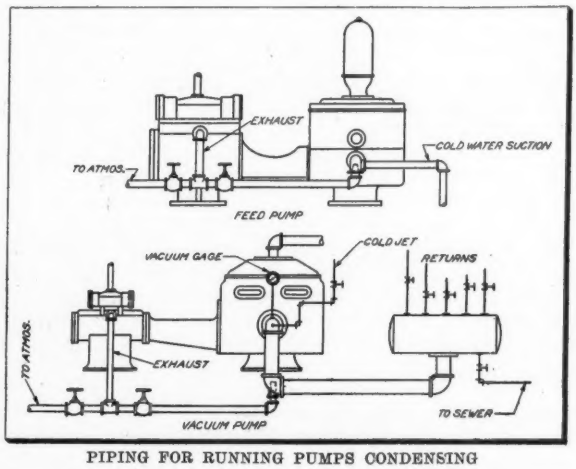
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

RUNNING PUMPS CONDENSING

THOSE who have not tried running a boiler-feed pump or a vacuum pump by piping the exhaust from the steam end into the suction of the water end, I should advise to try it and be convinced of the increase in available pump power.

My first experience was on a 6 by 8 by 12 vacuum pump, pumping returns from a heating system carrying 20 in. of vacuum to get the returns back from far away buildings. Before making the change it required that the ¾-in. throttle valve be opened 1 turn to get speed enough to maintain the 20 in. on the vacuum gage, and when the exhaust from this pump was turned into the suction, the pump would immediately start to run away. It became necessary to throttle down the valve to decrease the speed until the throttle was set to ¼ turn, which would give the same speed and same 20-in. vacuum that it took 1 whole turn noncondensing.



PIPING FOR RUNNING PUMPS CONDENSING

As in all vacuum pumps there is a cold water jet to help condense the steam and vapor, it became necessary to open it wider and here is where the drawback comes, because one should have a large receiving tank and much water is thus saved. Even then I find that the excess of water necessary to produce this vacuum is much more than is necessary for feeding the boiler unless one has other use for the water in the factories.

In the case of boiler feed pumps where water is lifted from cold water wells, the case is different from the vacuum pump because in the vacuum one gets nearly all of the heating returns back plus the extra water from the cold water jet, and when the pump exhaust is turned in, much more water being needed from the cold jet, makes too much water, and must be thrown away; but in the case of boiler feed pump lifting cold water, it is a success and no water is wasted.

A. C. Waldron.

DUPLEX PUMP DISABLED

AS to how a duplex pump may be made to run with one water cylinder disabled: some years ago when arc lighting was young, a Westinghouse engine driving a Brush machine broke its governor into little pieces and the eccentric could be whirled all around the shaft like a loose washer on an old bolt.

Now, everybody knows that a Westinghouse engine will not run with the eccentric disconnected from the governor. But there were the city streets in darkness and service had been promised. There was no reserve and no source from which current could be borrowed nor were there any repair parts on hand.

There was an engineer on the job and he hiked in record making time to the home of a skillful blacksmith, routed him out of bed, got him to the plant and told him how to make a clamp which would secure the eccentric rigidly to the shaft. In a little over an hour the clamp was in place and the eccentric set. Steam was turned on and the engine tried. A slow moving, patient oiler was placed on a high stool to handle the throttle and control the speed of the engine as well as he could, having one of the arc lights for a guide. For several nights he sat at his post while the varying intensity of the light from the street lamps excited a mild curiosity in the minds of the people served.

In due time new parts arrived and the patient oxeyed human near governor was relieved.

Duplex pumps might be operated with one water cylinder crippled. I have never known of an authenticated instance, though I have read 2 fairy tale like narrations of how the trick was turned. But, given a live engineer who had but the one means of getting water to the boiler, I think that a heap of lost motion given to the steam valve of the crippled side, some sort of a friction clamp applied to the idle side, compression valve closed and a live man at the throttle might make some sort of a "fist" at getting some water into the boiler, but I don't know.

F. L. Johnson.

CORLISS ENGINE SPEED

IN the question and answer department of June 15 issue I noted with interest an article by John Pierce on crude oil required. In course of the article, Mr. Pierce states that it is entirely out of the question for a Corliss engine of 500-hp. capacity to run at a speed of 120 r.p.m.

Now, if Mr. Pierce were sitting here with me in our engine room he would surely open his eyes. I have running here a 700-hp. rating Hamilton Corliss engine, cross-compound, 18 by 36 by 30-in., running at the very easy speed of 150 r.p.m. We do not start this engine very often as it is seldom shut down; about once a month or 6 or 8 weeks running 24 hr. a day with anywhere from 75 to 600 kw. on the generator which is direct connected to it. In the last 23½

months we have generated 5,049,700 kw-hr. with this unit which runs satisfactorily enough so that through its operation it has sold 4 or 5 other engines for its builders besides the 2 engines they are now building for us. One is a cross-compound 1400 hp., 24 by 48 by 42 in. to run 120 r.p.m. direct connected to a 1000-k.v.a. alternator; this unit we will install in our plant this season when our building and foundations are ready. We are also buying a 12 by 24-in. simple Corliss running 150 r.p.m. for direct connection to 75-kw. 125-v. d. c. exciter unit. All of these are regular heavy duty releasing gear Corliss engines.

Howard Glugs, Richmond, Ind.

PRESSURE ON BOILER

ON page 382, April 1 issue of Practical Engineer, is given solution to questions appearing on page 192, Feb. 1 issue. I question the correct reasoning in deriving an efficiency of 74 per cent for this triple riveted double butt strap joint. In the joint of which sketch is given the pitch at the outer row of rivets is 7 in. and diameter of hole is ⅞ in.

In this solution it says that the percentage of strength of the sheet after drilling, is found by subtracting the diameter of the rivet from the pitch, and dividing the remainder by the pitch and multiplying the result by 100, and it is shown that this gives an efficiency of 88 per cent.

As I understand this, it should be: From the pitch subtract diameter of one rivet hole (not rivet), and divide this by the pitch; the result thus obtained should be multiplied by 100, and in this case this would be

$$\frac{7 - 0.875}{7} \times 100 = 87.5 \text{ per cent.}$$

In all properly designed, triple riveted double butt strap joints the weakest point is the cross section of the plate at the outer row of rivets, and in this case there would be no rupture by just shearing the rivets in the outer row, the plate would have to tear at some place also, for instance the second row, or all the rivets in single and double shear could shear off, or at the first row of rivets. The section of plate here considered is 7 in. and the strength of this section is $11/32 \times 7 \times 60{,}000 = 144{,}375$ lb. and this represents 100 per cent. After one ⅞-in. rivet hole is drilled this would be $7 \times 11/32 - ⅞ \times 11/32 = 2.10{,}547$ sq. in. $2.105{,}47 \times 60{,}000 = 126{,}328$ lb. and $\frac{126{,}328}{144{,}375} = 0.875 \times 100 = 87.5$ per cent.

If the plate should fracture at middle row, one rivet in outer row would also have to shear before rupture would be complete and this would be represented thus: From the 7-in. cross section 2 rivet holes must be taken $7 \times 11/32 - ⅞ \times 11/32 \times 2 = 1.804{,}687$ sq. in., $1.804{,}687 \times 60{,}000 = 108{,}281$ lb. To this must be added shearing strength of one rivet. A 13/16-in. driven rivet has a cross-sectional area of 0.6013 sq. in., $0.6013 \times 42{,}000 = 25{,}254.6$ lb., $108{,}281 + 25{,}254.6 = 133{,}535.6$ lb. and it is seen that this is stronger than the cross-section between the rivets in the outer row, for $\frac{133{,}535.6}{144{,}375} = 0.9249$, and $0.9249 \times 100 = 92.49$ per cent.

Consider now the possibility of all rivets in single and double shear shearing off, rivets in double shear are stronger than rivets in single shear by 85 per cent, as rivets in single shear are allowed 42,000 lb. per sq. in. cross-section. In double shear this would be $42{,}000 \times 0.85 + 42{,}000 = 77{,}700$ lb. per sq. in. cross-section and $0.6013 \times 77{,}700 = 46{,}721$ lb. for one rivet. As there are 4 rivets in double shear this will be $46{,}721 \times 4 = 186{,}884$ lb. To this must be added one rivet in single shear, and this was found to be 25,254.6, therefore the resistance offered to shearing all rivets is $186{,}884 + 25{,}254.6 = 212{,}138.6$ lb., so it is seen the rupture can not take place in this manner.

Now, the only other place to consider is at the first or inner row of rivets. The net section of the plate at this point is the same as at the middle row, but here there are 2 rivets in double shear that must shear before this rupture is complete. It was found that it required 133,535.6 lb. to break at the middle row of rivets, and to break at the inner row it will take $133{,}535.6 + 2$ rivets in double shear, $93{,}442 + 133{,}535.6 = 226{,}977$, it is seen this is the strongest. The weakest point in this joint is, therefore, between the rivets in the outer row, this was found to be 87.5 per cent, and the allowable pressure on this boiler becomes

$$\frac{60{,}000 \times 3437 \times 0.875}{27 \times 5} = 133.66 \text{ lb.}$$

P. A. Guttormsen.

UNITS FOR POWER MEASUREMENT

AS one of the authors of the original paper on The Myriawatt, I write to express my appreciation of your thoroughly judicious editorial, A New Unit Proposed, in the June 15 issue.

There appears to be some confusion as to the purpose of the Myriawatt. The Kilowatt, while purely a mechanical unit based on fundamental units, has become recognized as the unit of prime-mover electrical output. It was originally intended that the Myriawatt should differentiate the dynamic input from the output of a machine, and yet be founded on the same system of fundamental units as the recognized unit of output.

The term Boiler Horsepower is never heard of outside of America. The question is: In the future, are we going to continue to tie ourselves down to such a confusing unit on account of mere local sentiment and custom, when a simple substitution of a known unit of practically equal value will harmonize our system of powerhouse units with that used by practically all other civilized countries? And what better name is there for such a unit than the name of that great practical steam engineer, James Watt?

Haylett O'Neill.

RACING ENGINE

IN reading Practical Engineer I saw a question in regard to an Ames engine racing. I should say that I have a Buckeye engine 17 by 32 in., running at 101 r.p.m., girder frame, type A, with the centrifugal governor. It would race for 2 or 3 revolutions and then almost stop. This was due to one of the weight arms. The pin was cut and formed a bur on it so that the weight could only go half way out, in other words, the cutoff valve would close at one end and only close half way on the other end. This, of course, would cause it to race. I replaced the pin with a new one and have had no further trouble. I can now run with throttle wide open.

My experience with centrifugal governors is that in using oil they do not get lubrication enough. Now I have put on grease cups and find them much better. There are 2 more causes for racing, a flat spot on cut-eccentric and a broken automatic cutoff blade. I have met with these troubles in my experience.

J. W. B.

BUYING COAL ON THE B.T.U. PLAN

WE have been buying coal on the B.t.u. plan for 2 yr. and we have found good sides to the question and some not so good. We have not, however, had the experience that Mr. Kavanagh tells of in his article in June 15 issue, that of the chemist refusing to analyze the sample because there was too much slate in it. Our chemists analyze anything we send them. Our coal is delivered at our plant by wagon from the railroad a couple of miles away. We sample the car by taking a scoopful from each of 4 wagons, and as the wagons load 2 and 3 at a time, we get a fairly good aggregate of the car load. These 4 samples are mixed and divided in the regular way with which almost everybody concerned is familiar and the sample so derived, amounting to a quart, is sent to the chemist.

If the contractor desires, we send him a sample from the same large sample taken and he checks up on our chemist. We have never had but one argument and then the contractor said he did not think he was getting a square deal somewhere. Whether it was in the chemist or the man taking the sample he did not know, but wanted to find out. He was brought here to the plant, shown how the sample was taken and expressed satisfaction with the manner of taking the sample. To check up on the chemist on those car loads under discussion, he took 4 samples from different places in the bunkers and took them away with him. A few days later he accepted without any argument our engineer's decision on the case and accepted payment.

When the B.t.u. plan is followed with honesty and co-operation between all parties concerned, it is absolutely fair, but there are just as many chances for playing a skin game with B.t.u.'s as there are with peas and shells.

I don't know whether buying by the B.t.u. plan will stop the nefarious practice of introducing slate and "nigger heads," as mentioned by Mr. Kavanagh, or not, but if slate or nigger heads are introduced into our coal, we do not pay for it because the price of our coal is based on a contract for so much money for so many heat units and the price varies with the analysis. The variation is not great with us for we have been fortunate in buying our coal from people who are anxious to do the right thing by us and we, on the other hand, desire that our contractor gets every cent that is coming to him.

A rather amusing incident happened some time ago that, like the dirty shirt, came out all right in the wash. I always watch the first day's run on a new batch of coal and was surprised to receive a call from the contractor asking me to state explicitly what was the matter with that last shipment of coal. I said there was nothing the matter with it—in fact, it was a little above the average—being, as I had learned, fresh from the mines. He then wanted to know why I had entered a report against it then. I told him there was nothing doing in that line so far as I knew and said we would look up the report from the chemist. Now, it seemed that Mr. Man had not looked up the chemist's report, which is always sent the contractor, but upon hearing the verbal bad report on the coal had piled right out after me. He was much surprised to find the chemist gave him a lift of several cents over the contract price, showing that the coal was above the average in heat units. We then started to run down the bad report and found that one of the firemen had remarked to someone else that the last coal was poor stuff because it coked so badly. The someone else had deemed it his duty to report to the Big Man and he without consulting me had shoved it along to the contractor. Mr. Chemist with his little apparatus was thus able to help me mollify a mad contractor, show up a lazy fireman and—well, I never heard whether it showed the other man anything or not.

Our operating expense is in exact proportion to the value of the coal as shown by the chemist's analysis. I can easily see where the proportion would be very different where the sampling is done as described by Mr. Kavanagh and the testing done by such a chemist. But if all parts of the work are done as they should be, honestly and squarely, it is the correct way to buy coal as viewed from the standpoint of this practical engineer.

We are buying about 150,000 tons of coal of all kinds and descriptions and we are saving money over any other system of buying. Some dealers will not sell to us and I don't blame them under the circumstances after giving their coal a test. I have found that the Golden Rule will work with a coal contractor or dealer as well as anyone else, and, boys, that is a pretty good old Rule to hang up over the door and to follow in dealing with everybody.

C. A. Scott.

SLOTTING COMMUTATORS

HAVING noticed the letters of Mr. Pierce, Mr. Unsworth and Mr. Hayward, and judging from my own experience, I think that Mr. Hayward is right. I never had any punctured commutators on the motors which I slotted, but on several motors with wide bars when heavily loaded I had many punctures. Did any of the readers of Practical Engineer ever have armature coils burn out on G. E. motors? Mine were caused by overloading and there was a deal of smoke and some fire and no time to change armature then, so I have often cut the wire of 2 coils to get them out of contact and finished the day with the same armature. After closing time I changed armatures and repaired the burned one at leisure. B. C. White.

A SCALED INJECTOR

HERE is a kink I discovered and have used for the last 20 yr. Where we had limewater to contend with, we found it almost impossible to keep water in the boilers unless we kept the injectors running most of the time, on account of the limewater corroding our check valves between injector or pump and boiler.

After trying all kinds of check valves, all of which would stay tight but a short time, I took the vulcanized rubber out of a 1¼-in. Jenkins valve and cut off a section of 1-in. steam hose the thickness of the rubber and placed it in the valve, replaced the valve and cap and although the seat was badly corroded, it held and was still doing its work when I came away 4 yr. afterwards. H. C. Balch.

SAFETY ENGINE STOP

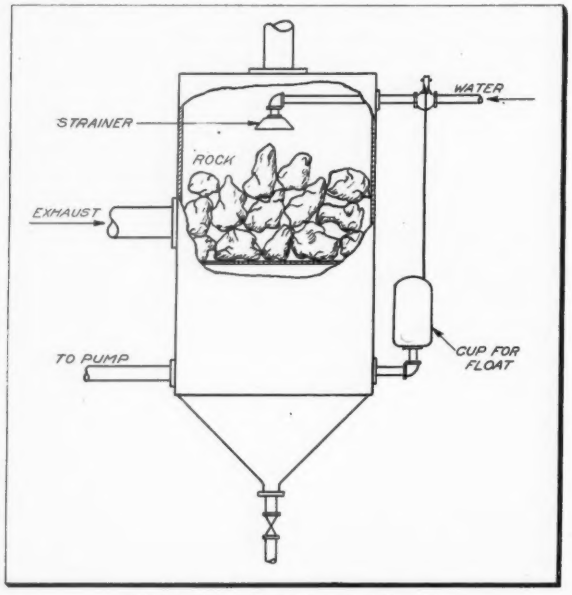
IN the March 15 issue J. G. G. shows on page 332 a safety engine stop which he has devised to be used in connection with the governor. This device seems to me unnecessary in connection with the Gardner governor which he shows, as this type of governor alone will stop the engine when the belt breaks. A. J. Anderson.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Improvised Open Heater

A CHEAP and efficient open heater may be made from any old cylindrical container. Put a grid partition about half way, cut a manhole in the upper half and fill with large rocks, cut places for the exhaust as shown in diagram, also tap for pump suction as shown.



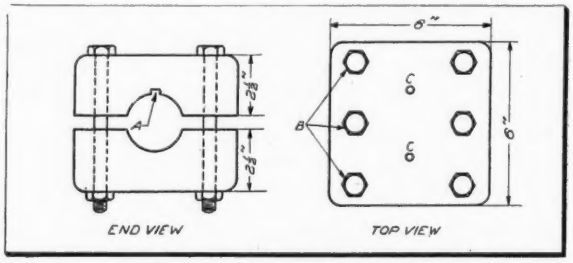
HOME-MADE FEED-WATER HEATER

It may also be rigged for automatic regulation of water as shown or as was indicated in a recent issue of Practical Engineer, with hose and container with counterbalance. The latter is an excellent idea. I made a heater like this out of the one I had and it gives excellent satisfaction. A. J. W.

Mending Broken Water Wheel Shaft

A PLANT of which I took charge at one time had a double water wheel (or 2 wheels on one shaft), of about 40 hp. This wheel was allowed to get out of line and it wasn't long before the 3-in. shaft broke about 3½ in. from one of the wheels on the inside. In order to put in a new shaft we would have to rip off the tops of wheel-pit, which couldn't be done at that time on account of high water. The machinist was called in and he made a cast-iron split coupling as shown in the figures.

The illustration shows an end view with ⅞-in. keyway cut at A, and a top view with 6 bolt holes drilled for ⅞-in. bolts, and 2 holes at C drilled and tapped for ½-in. set screws for stopping key from working out. We did not have to cut a keyway on the shaft as there was one there. After the shaft was put in line, the coupling was put on and the bolts were put in place so that the break in the shaft came about mid-way of coupling, then the key was put in and the 6 bolts tightened and the 2 set screws for



VIEWS OF CAST-IRON COUPLING

key were tightened. The coupling held and the water wheel gave as good service as before.

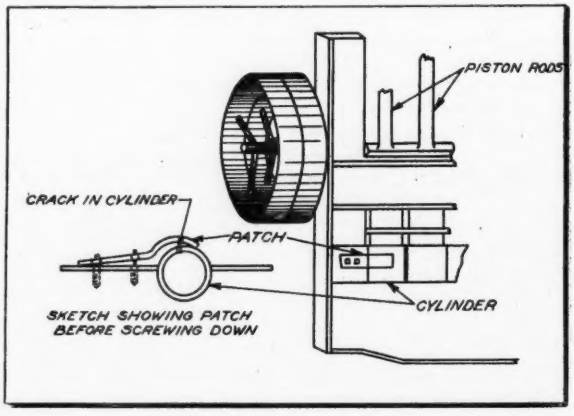
A. A. Williams.

Repairing a Triplex Plunger Pump

THE drawing herewith illustrates how repairs were made on a cracked cylinder of a 7 by 8-in., single acting, triplex plunger pump.

The pump in question has been in service about 10 yr., supplying water for elevators and hydraulic derricks at a pressure of 150 lb.

About 3 yr. ago metallic packing was installed and the glands were screwed down too tightly, thus cracking one of the cylinders. The clamp illustrated in the



REPAIR OF PUMP CYLINDER

drawing is made of steel ¼ in. thick and shaped to fit the cylinder tightly over the cracked portion, and bolted to the frame as illustrated. Some sheet packing was placed between the cylinder and the clamp, thus making a water-tight patch on the cylinder.

These repairs were made about 3 yr. ago and the pump is still giving satisfactory results.

A. P. Broadhead.

Questions Answered and For Answer

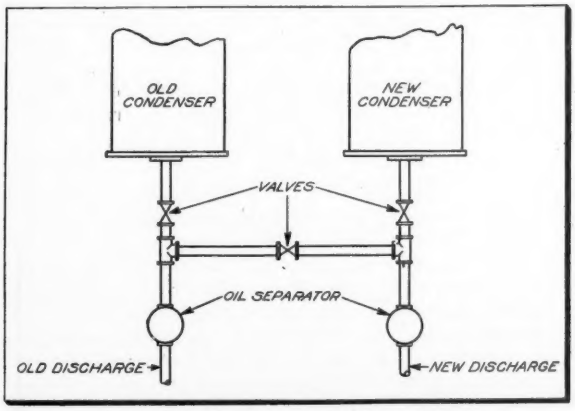
Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Refrigeration Problem

WE have a refrigerating plant consisting of a 15-ton ammonia compressor, direct expansion. The suction is 2-in. and the discharge is 1½-in. The oil separator consists of 2 pipes each 7 in. outside diameter by 5 ft. long. Underneath these 2 drums, is the oil reservoir, 6½ in. in diameter by 21 in. long. The pipe from the oil separator to the condenser is also 1½ in.

We are now installing a 25-ton ammonia compressor which has a suction pipe and a discharge pipe of 2½ in. each. Now the discharge pipe of the new compressor should be cut in and connected to the discharge pipe of the old compressor or between the old compressor and oil separator, reducing it to 1½ in., then the old 1½-in. pipe between the oil separator and condenser should be removed and replaced with 2½-in. pipe.

This reducing of the size of pipe from compressor to oil separator does not look reasonable to me. Will it not interfere with the working of the compressor



PIPING CONNECTIONS FOR 2 CONDENSERS

requiring more power and more water for cooling the ammonia gases to give equal results than if the piping were not reduced in size? Would you not deem it a necessity that a new oil separator be also installed that would have the capacity of the new compressor that is same size of pipe? If so, give reasons, and the effect it would have on the compressor and the whole system. The compressor is motor belt driven.

A. S.

A. We take it for granted that you propose to operate both machines at one and the same time, and while you do not say, we take it that you are installing new ammonia condenser with new machine. Should this be so, we should prefer to make cross connections as shown in the sketch.

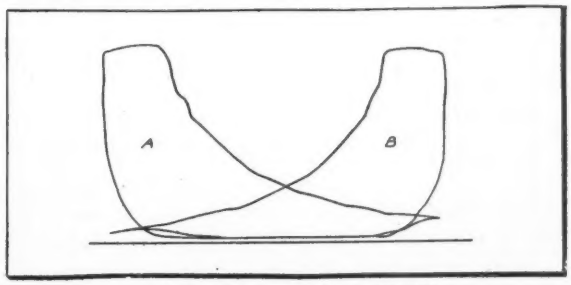
We would not recommend that you run both discharges through the 1½-in. pipe to condenser, as that would be entirely too small, although the 2½-in. pipe would be large enough for both of them. We should also advise you to put in oil separator or trap large enough to take the 2½-in. pipe. The size of the pipe leading to the condenser should have no effect on the amount of water required for condenser; the only thing would be that it might require slightly more pressure to force it through this small and restricted passage. This, of course, would require more power to operate your machines.

Criticism of Indicator Card

KINDLY explain what is wrong with the accompanying indicator card taken from a 12 by 30-in. Corliss engine, 80 lb., 90 r.p.m. H. W.

A. The principal trouble with the engine is, that there is far too much exhaust lap. The greatest evidence of this is the extremely late release, which does not occur until the piston has traveled 3 or 4 in. on the return stroke.

This is more pronounced on the end marked "A" (in the absence of definite information), than at the end B. Then also, the compression is much too high for the speed and pressure at which your engine operates. It is now very close to 6 in.



CARD FROM A CORLISS ENGINE

Reduce this lap to the point where you get a later compression and an earlier release. Judging by the remainder of the card, this may be all that is necessary, but if upon trial with the indicator, you find that release is still late with a compression of, say, 2½ to 3 in., it may be necessary to advance the eccentric slightly, to get a free release, and if necessary reduce the exhaust lap still further to keep the compression within the limits just stated.

But bear in mind that advancing the eccentric, advances every event of the valves (except the cutoff, and that it may then be necessary to increase the steam lap in order to have admission take place at the proper time, which appears to be about right in the card submitted.

Study the situation carefully, and do not make a single adjustment until you have decided just what is necessary, and want to do in order to secure the desired results. Do not screw the rods in or out "to see what

will happen," or "to see if that will help it." Don't "cut and fit." Study the situation and use the indicator.

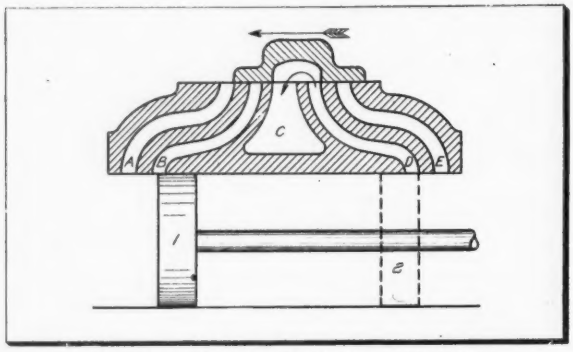
The load is quite evenly balanced between the 2 ends of the cylinder. It is quite possible, however, that there is a leaky steam valve at end A as the expansion line seems to carry out somewhat higher than it should.

G. H. Wallace.

Steam Pump Question

WHY has a duplex steam pump 5 ports? D. W.

A. On duplex steam pumps—commonly considered as those without flywheels or cranks—the length of piston stroke is not definitely controlled as on pumps with crank connection to piston. It becomes necessary to limit the stroke by some means to prevent the piston striking the cylinder head. This is accomplished by means of the 2 inner ports D and B, as shown in the sketch. The 2 outer ports A and E are only for live steam. The center port leads to the exhaust chamber for steam leaving the cylinder, and the 2 remaining or inner ports, B and D, are the exhaust passages.



NECESSARY PORTS ON DUPLEX STEAM PUMPS

The operation is as follows: Steam being admitted at the left-hand end of the cylinder, it forces the piston forward, expelling the steam on the right-hand side, meanwhile, through exhaust port D, the valve traveling to the left as indicated.

When the piston reaches position No. 2, all further escape of steam through port D is cut off and the remaining steam on the right side of the piston is compressed, acting as a cushion to the piston and thus gradually bringing it to a stop without jar or shock. On the return stroke similar operations occur at the other end by the cutting off of exhaust steam through port B.

F. W. B.

Questions by Massachusetts Inspectors

THE following questions were asked a short time ago by Massachusetts inspectors:

1. What would you do if your lights go down and then come up?

2. What are the different ways to leave a heating plant for summer?

3. How could you tell if a cast-iron boiler was pitting?

4. If you had 2 cast-iron boilers in a heating plant and in the mornings you found the water higher in one than the other, what would be the cause?

H. L. P.

A. If the lights become dim, and then bright, the trouble would likely be from one of 2 causes: first, a sudden change of load, as starting a large motor or a heavy electric elevator will cause the lights to dim for a second, especially if the engine is small, or, stopping a heavy machine suddenly will cause them to burn above the normal candlepower; second, if the engine is of the shaft governor type sometimes the governor will stick a little, especially if lubricated with grease, or the bearings may be badly worn, causing the inertia bar to work hard, and in some cases the eccentric may be keyed up a little too tight, causing excessive friction which will cause the governor to stick in one position. When it does this will change the speed of the engine enough to affect the lights. If this fluctuation of the lights occurs frequently, watching the ammeter and voltmeter will show whether it is caused by a change of load or not. Also if the engine is watched closely, the action of the governor will indicate whether or not it is due to the racing of the governor. Sometimes it might be due to defective design of governor, but usually it is caused by some resistance to the free action of the governor.

2. There are several ways, some good, and some bad, in which a heating system may be laid up for the summer. Some systems are left just as the fire goes out, but the proper way is to drain all the water out of the system, disconnect some of the pipes at the top of the system, and leave the boiler open, which will allow air to circulate through the system and keep it dry. The boiler should be cleaned inside and outside, including the ash pit, firebox, combustion chamber, etc. All traps, coils, radiators, water pockets, drip legs, etc., should be drained. The return, or vacuum pumps, and feed-water pumps should have the cylinders and valve chambers opened, and all the wearing surfaces painted with a coating of graphite and cylinder oil. The water end should be drained, opened, and the soft piston packing removed, also the rod, and valve stem packing should be taken out. The thermostatic regulator, if one is in use, and the air pump, and regulators or thermostats should be cleaned and oiled to prevent rusting. Before shutting down, the whole system should be gone over and examined, and notes made of any needed repairs, leaks, defective valves, or of changes that are found desirable, so that the work can be done after the system is closed down.

3. In order to determine if a cast-iron boiler was pitting it would be necessary to examine the inside of it. These boilers are of rather irregular shape, and it would be hard to examine all parts without taking them apart. The pitting in any boiler occurs, as a rule, near the point where the return water enters, and by disconnecting the return pipe, and using an electric light that would go through the return pipe, some information could be gained by looking in through these openings. If there appeared to be very much pitting it might be found advisable to take the sections apart and examine each one more thoroughly.

4. If there was no equalizing pipe between these 2 boilers these conditions might be caused by carrying a hotter banked fire in one boiler, which would drive the water out of it, and as the pressure would be slightly higher the return water would tend to enter the cooler boiler. Another cause might be that a valve in the return line to one boiler was partly closed, or the arrangement of the feed pipe such that one boiler fed more easily than the other, or the check valve to one boiler might have become stuck. The same trouble might be caused by the steam, or flow pipe as with the return line.

There might be some other things that would cause a different water level in the 2 boilers, which would depend entirely on the existing conditions, and which could be found by an actual examination of the heating system. J. C. Hawkins.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Magnet Problem

REFERRING to L. K.'s magnet problem, page 567, June 1 issue, I offer this solution on the assumption that measurements and material are as I assume.

Taking material as grey cast iron, scale 7/32 in. to 1 in. in drawing and the path of lines on center of legs and base, 40,000 lines per square inch and u = 258 (permeability). Base is shown 10 in. over all, but to centers of legs the distance is 7.42 in.

$$\text{Reluctance of base} = \frac{7.42 \times .3937}{(.75 \times .75) \times 258} = .0201$$

$$\text{Reluctance of A to B} = \frac{6 \times .3937}{1 \times 258} = .009{,}16$$

The pole face, which I took from the center of leg to the end of horizontal diameter of bore, equals 2.28 in.

The area of the lower side of the pole piece is 5 in. $\times$ 4.57 in. = 22.85 sq. in.

$$\text{Pole piece} = \frac{2.28 \times .3937}{22.85 \times 258} = .000{,}152$$

If this magnet is of wrought iron it will carry 100,000 lines per square inch and have permeability of 408 in place of 258. There is a dividing line in the center base but I assumed the base was solid.

Charles M. Green.

Gasoline Engine Trouble

I HAVE been having a lot of trouble trying to make a 2-port, 2-cycle engine run. The following description is fairly accurate.

Bore is $5^3/_{32}$ in. by 5 in. The crank case is of round section $6\frac{3}{4}$ by $9\frac{1}{4}$ and there is a space of $3\frac{1}{2}$ by 4 in. between the upper edge of the crank case and the inside part of the piston when the piston is on its lower center. There is a distance of $1\frac{7}{8}$ in. between the top of the piston and the cylinder head on the upper center.

The intake is by-passed on the outside through a pipe 1 in. in diameter and the intake ports are of oblong section $^9/_{32}$ by $\frac{3}{4}$ in. and 5 in number.

The exhaust ports consist of 5 openings $^5/_{16}$ by $\frac{3}{4}$ in. and just underneath I bored a row of 6 holes $^5/_{16}$ in. in diameter, thinking that the exhaust might be cramped.

The engine will sometimes run for quite a while but does not give any power, and sometimes it gives power for a short time and then dies away, usually making 2 explosions so close together that I believe the incoming charge is ignited.

The upper exhaust ports are fully open and part of the lower ones before the intake starts to open. The piston travels $\frac{1}{8}$ in. below the intake port before starting its compression stroke. There is also a marked tendency to flood in the base no matter how the carburetor is adjusted. I am using a $1\frac{1}{4}$ Schoebler.

Can you send me any definite information as to how to figure the port area and the relative proportion of the base and cylinder compression? E. L. M.

Overheated Babbit

M. S. R.'S question in regard to babbit metal, in the May 15 issue, puts me in mind of an experience I once had that may be of interest to others. I was employed as assistant engineer in a paper mill and the second week I was told to overhaul a 150-hp. engine. It was the practice in this mill to turn out all crank and wristpin brasses, and fill them with babbit. The crank of this engine was oiled through a hole in the pin from a stationary cup. On removing the brasses I found a strip $\frac{1}{2}$ in. wide had melted out of one of them, filling the hole in the pin.

This engine had carried a 112-hp. load for 6 24-hr. days just before shutting down and had not run hot in that time. The oiler said the crank ran hot for about 2 hr. a month before that, but cooled off quickly as he applied some cylinder oil and graphite, and he thought it was not worth mentioning in his report. It has been a mystery to me how a small strip could get hot enough to melt without losing all of it.

V. C. Wood.

Correction

ATTENTION has been called to an error which appeared in the June 15 issue, page 603. The answer to question 6 stated that if an eccentric were planed off $\frac{1}{2}$ in. it would decrease the valve travel. The question evidently meant "turned" instead of "planed" and in this case there would be no change in valve travel if the eccentric were turned on its original center; however, if the center were shifted $\frac{1}{2}$ in. and the eccentric turned on this center, the effect would be as stated in the answer given.

THE MISSISSIPPI RIVER POWER CO. has completed its first installation of generating units at the Keokuk plant, and began the distribution of high tension current to St. Louis on July 1. The units now installed provide for developing 100,000 hp., and an additional 50,000 hp. will be installed as fast as needed. Sixty thousand horsepower is to be transmitted to St. Louis for the Union Electric Light & Power Co., and current will also be furnished to the cities in Iowa and Illinois as required. When the first 150,000 hp. has been taken care of, the foundations are ready for another power house, a duplicate of the first one, making the total ultimate development 300,000 hp. in the plant.

PRACTICAL ENGINEER

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SAFETY FIRST

Given the choice of $10,000 and both arms taken off, your present condition and safety, which would you choose? Safety isn't usually as costly as that, but the question in another form becomes, How much is safety worth? Considering the distressing accident at Racine, Wis., described in our last issue, and which demonstrated so impressively the enormous force for destruction stored in a steam boiler, what is it worth to a community to be safe-guarded, and how much can those employed about a boiler well do to ensure their own safety? Is boiler inspection a luxury or a reasonable necessity?

Because the disaster happened in Racine some details as to what the lesson may teach are interesting, although Racine is probably taking no more chances than most other cities where no systematic inspection is in force. The data are given by an engineer whose standing and reliability are beyond question.

Within the business district are several boilers in daily use that are as old as the one on the Peck and are still considered as safe as when new. Two are over 20 yr. old that were built for only 80 lb. pressure when new, and they are carrying 80 lb. as the maximum at the present time, when as a matter of fact, this pressure ought to be reduced considerable, in the interests of safety to those whose business requires that they pass daily within range of these dormant infernal machines.

Several months ago the safety valve of one of these boilers required some attention and when reassembled again and placed in service, an error on the part of the attendant raised the pressure to 120 lb. before the valve released.

Stop and realize that this boiler was carrying nearly 75 per cent more pressure than it was built for more than 20 yr. ago.

Several years ago a boiler on which no insurance was carried, had been in its present place 18 yr., under steam every day, and was in a previous location in the city for 8 yr. and was secondhand when placed there. Thus from the best information at hand this boiler is 35 yr. old, and thousands of citizens pass it daily.

Another boiler was found with the lever safety valve so loaded with weights, that it required 260 lb. pressure to relieve it. The first inspection made after taking charge, revealed 22 rivet cracks in the shell, and one of the plates corroded half way through in a dangerous location.

There were 150 persons, half of them women, who worked over this smouldering mine. The pressure was reduced from 110 lb. to 60, and used on low pressure for such work as could be done with it. Meanwhile the insurance inspector was sent for, who promptly reduced the maximum pressure to 65 lb.

This boiler was 21 yr. old and insured. Insurance itself does not make a boiler safe any more than life insurance prevents death, but it does show that when

a boiler has been in service for 20 yr. or more, it is not to be depended on from one inspection to the next.

In one of the churches there is a boiler in use that is positively dangerous. Yet every Sunday, the house is filled with worshipers, lifting their voices in prayer and praise with a mine in the basement that could hurl all of them to instant death.

About the beginning of the heating season last fall, examination was being made of the heating apparatus. Suddenly there was a deafening roar in the boiler room, from which the attendant came, quite leisurely. Inquiry revealed the fact that the safety valve had stuck and that the pressure had gone up to 120 lb. The attendant said that they were supposed to blow at 70 lb. "but that they got stuck sometimes."

What shall we do? Shall we leave a boiler in service till it explodes before it is discarded? Shall we keep them to a good ripe age, a daily menace to every citizen?

Laws now provide rigid examination for those handling drugs where a mistake might result in injury to one or two at most. Those who practice medicine must prove themselves capable of prescribing for and helping those who are sick. But what of a danger which may threaten hundreds who are in the best of health with death or serious injury?

Unequal expansion and contraction which is ever present in every boiler, to a greater or less extent can be so aggravated by unskilled attendance, that the life of the boiler is shortened.

Improper firing and the manner of introducing the feed water into a boiler, have much to do with the early failure, also.

The right and proper method of handling this problem, once and for all, is a law of state wide effect. One that will insure competency of attention and examination, and one that will be of the greatest good to the greatest number. The real remedy would be a law nation wide in its effect, such as is in use in several European countries.

Then get a clean and fearless man to fill the position, and weed out some of these boilers that have been on the verge of disaster for years, and some of these attendants that know nothing of a boiler, will not learn, and don't want to learn.

It might not be unwise to treat the matter as it is in Germany. There, they condemn a boiler after 20 yr. of service, just on general principles. If a manufacturer had allowed for depreciation, he ought to be glad to discard a boiler after 20 years' service.

Let us have safety first; prosperity will then take care of itself.

NEWS NOTES

TEXAS POWER & LIGHT CO., has announced that it will erect a large power plant at a cost of about $1,000,000, 3 miles north of Denison on the Red River.

EDWARD N. LAKE, formerly in charge of the electrical division of the Stone & Webster Engineering Corporation at Boston, will hereafter represent it at Chicago.

IN THE HEART OF the Pocahontas coal district in Ohio, the Norfolk & Western Railroad intends electrifying its lines, and will not follow the usual custom of several other railroad companies and purchase power from hydro-electric corporations.

The company is asking bids for its own generating station. It is to be of 24,000-hp. capacity and coal will be used as fuel.

THE ADAMS CONSTRUCTION CO. of Chicago, was recently awarded the contract for building the $250,000 addition to the power plant of the Fort Wayne & Northern Indiana Traction Co., at Ft. Wayne, Ind.

AT COLUMBUS, OHIO, it has been decided to erect a power plant at the state hospital and also one at the Girls' Industrial home near Delaware. It is the purpose of the board of administration to erect these plants so that sufficient power can be generated to do all the necessary power work about the respective institutions.

Plans for the erection of the additions at Gallipolis and the hospital for feeble-minded will also be drawn at once. In each case $20,000 will be spent.

ARRANGEMENTS ARE UNDER WAY for a special train from Chicago to Kansas City, on the night of Friday, August 14, for those who will attend the Gas Engine Show of the National Gas Engine Association. This train will consist of sleeping, observation, dining and cafe cars, and will be known as the "Gas Engine Special." The fare from Chicago to Kansas City is $10.75, and the lower berth rate, $2.50. Reservations can be made with E. J. Perkins, St. Joseph, Mich., or H. W. Jones, People's Gas Light & Coke Co., Chicago, Ill., for accommodation on the train.

BROCKWAYVILLE, PA., is to have one of the largest electric power plants in the west end of the state. The Northwestern Mining & Exchange Co. is erecting the new plant for the purpose of furnishing power for the various plants of the company in the Toby Valley as well as at Crenshew and Brockwayville.

The main building will be 80 by 100 ft., built of brick and stone. It is within 200 yd. of the Johnson Run coal tract, which contains 5 veins of good coal and extends over an area of 3000 acres. The plant will be equipped with powerful boilers and dynamos and the current to be generated for the mines of the company and transmitted by wire will be tremendous.

AN IMMENSE POWER PLANT will be erected in the bed of the Mohawk River, about 600 or 700 ft. below the Cohoes falls, on the acre of land recently granted to the Cohoes Co. by the State of New York. The secretary of the company stated recently that he was of the opinion that the actual work on the project would be begun before long. He said that the work will cost approximately $1,100,000 and the plant will be the equal, if not superior, to any in that part of the country.

The structure will occupy a part of the river bed that is partly encircled by precipitous walls, and to complete the protecting walls formed by the river bank, a high concrete wall will be constructed to enclose the building on the sides that are left exposed and prevent damage by the water of the Mohawk in flood periods. The plans call for a building of brick and concrete 170 by 67 ft., and several stories in height. At the point nearest the river a tower 90 ft. high will extend above the main building. Through this tower and by means of an iron bridge from the gate house, access will be obtained to the plant.

An important part of the equipment will be a huge electric crane which will be controlled from the tower and will be used to take heavy pieces of machinery from the river bank into the station. The water power from which the electric energy will be generated will be taken from the present canal of the Cohoes Co. to the plant through a waterway about 220 ft. long and 200 ft. wide.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

AUDIFFREN - SINGRUN REFRIGERATING MACHINE

SHORTAGE in the crop of natural ice makes the question of refrigeration vital to the dealer in perishable provisions, and the consumer who must store considerable quantities.

A satisfactory answer to the question is found in the Audiffren-Singrun refrigerating machine, sold by the H. W. Johns-Manville Co., of New York City, and furnished in sizes to make from 11 to 110 lb. of ice an hour. This machine can be used entirely for refrigeration or partly for that and partly for ice making as indicated in Fig. 2.

In refrigerators, it does away with the muss and sloppiness caused by the ice man, and is sanitary because it avoids breeding of germs, due to the dampness of the melting ice and to the fact that the temperature runs from 50 to 70 deg. F. Refrigerators cooled with the Audiffren-Singrun machine can be constantly maintained at a temperature of 35 to 40 deg. which makes breeding of disease germs impossible by low temperature and almost total absence of dampness.

Construction is so simple that, to start it, all that is necessary is to turn on the power and water; to stop it, turn off the power and water, and there are no connections to leak. Pressure is not sufficiently high to cause an explosion, even if the machine were run without condensing water or otherwise abused; and in the event of accident from any external cause the liberated gas could not produce fatal or even dangerous results.

FIG. 1. AUDIFFREN-SINGRUN REFRIGERATING MACHINE AND BRINE TANKS

Careful tests made by the inventors and manufacturers and confirmed by similar tests made by Prof. Charles L. Norton of the Massachusetts Institute of Technology, and by United States Government officials, have shown that these machines operate with great economy of power and cooling water. Any form of power is suitable for operating the machine, but generally speaking, the electric motor is the most practical and convenient means and is usually preferred where it is available. The machine can, however, be operated equally well by a gas or gasoline motor, by a steam engine, or by a water-wheel or turbine where a fall of water is available.

The Audiffren-Singrun machine operates on the compression system, using sulphur dioxide as its refrigerating agent, so controlled that by no possibility can the machine operate to increase its pressure-limit. The revolving member is simply a shaft carrying at one end a drum, at its middle another drum, and at its opposite end a pulley, gear or other means of revolving it. Its appearance is practically that of a large dumbbell, and when installed its end drum is in contact with water, brine or other liquid to be cooled.

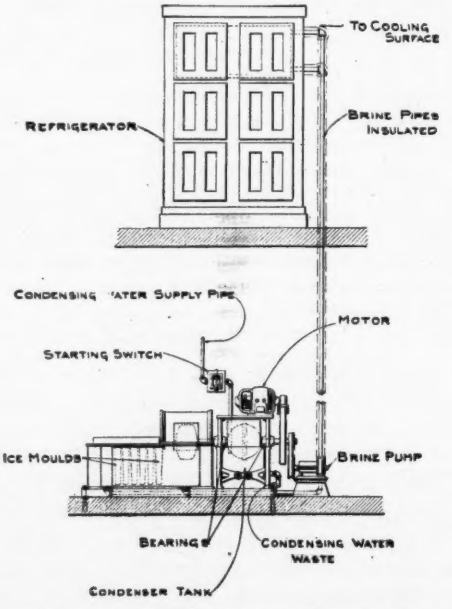


FIG. 2. TYPICAL INSTALLATION FOR COMBINED ICE AND REFRIGERATION WITH PLANT IN BASEMENT

The "Dumbbell" is sent out from the factory completely charged and ready to operate. The air is entirely exhausted and the charge of sulphur dioxide and pure neutral oil is admitted, after which the machine is hermetically sealed. The working parts are thus constantly lubricated by a distribution of oil so that metal-to-metal contact cannot occur. Pressure in the condenser is constantly forcing oil between the working surfaces of the compressor.

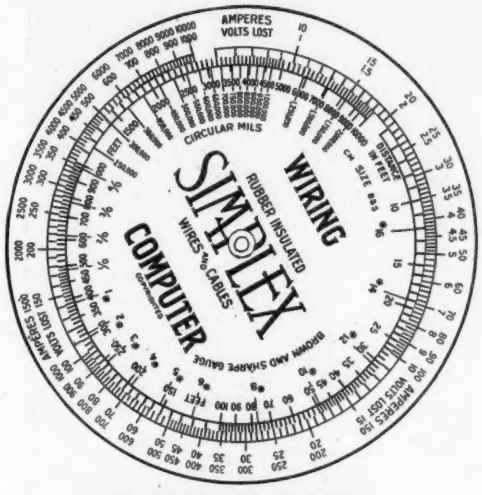
Oxidation of the lubricating oil is absent as there is no oxygen present; it is impossible to draw air into the machine because the dumbbell is hermetically sealed, so that no dust can enter to cut or wear the working parts. Examination of machines that had been running continuously for more than 5 yr. showed no appreciable wear of the moving parts.

SIMPLEX WIRING COMPUTER

ELECTRICAL engineers and wiremen will appreciate the wiring computer which the Simplex Wire & Cable Company will send on request.

The computer is mounted on stiff thick celluloid of a convenient pocket size. It consists of a circular slide rule particularly adapted for wiring calculations.

By a single setting of the computer the following results may be obtained: The size B. & S. gage of a wire is readily determined by setting the disk to correspond to a given distance of distribution for a desired voltage drop and the current which the wire is to carry; or given the size B. & S. gage, the current to be carried, and the distance of transmission. The resulting voltage drop may be read directly upon the


AMPERES
VOLTS LOST
CIRCULAR MILLS
FEET
SIMPLEX
WIRING
COMPUTER
RUBBER INSULATED
WIRES and CABLES
BROWN AND SHARPE GAUGE
DIRECTIONS.
TWO WIRE CIRCUITS.
ALWAYS obtain results by combinations reading red to red and black to black.
To determine SIZE :-set DISTANCE under VOLTS LOST and read SIZE under AMPERES.
To determine VOLTS LOST :-set SIZE under AMPERES read VOLTS LOST over DISTANCE.
To determine AMPERES :-set DISTANCE under VOLTS LOST read AMPERES over SIZE.
To determine DISTANCE -set SIZE under AMPERES read DISTANCE under VOLTS LOST.
"DISTANCE" is the length in Feet from source of supply to point of distribution
EXAMPLE :-To determine the size of conductor necessary to transmit 200 amperes 1500 feet with 25 volts lost:-set 1500 (distance) under 25 (volts lost) and read 250,000 circular mils (size) under 200 (amperes).
Based on formula :-Circular mils = Feet (supply to distribution) X 2 X 10.7 X amperes / Volts Lost.

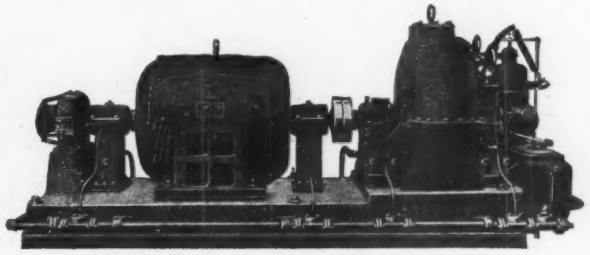
THE SIMPLEX WIRING COMPUTER

computer. In like manner, the current may be found at one setting for a desired voltage drop with a definite sized wire and distance of transmission. Finally, the distance to correspond to specific conditions of voltage drop, the current, and size of wire may be found by a single setting of the disk. The setting of the disk is simple and directions for attaining those 4 different results are given explicitly at the foot of the card. Much laborious figuring is avoided by its use. On the reverse side of the pocket card are handy tables of wiring data and table of decimal equivalents of fractions of an inch.

Anyone who desires one of these wiring computers may receive one by communicating with the Simplex Wire & Cable Co., 201 Devonshire St., Boston.

NEW TERRY TURBO-ALTERNATOR

THE Terry Steam Turbine Co., Hartford, Conn., which builds turbo-generator sets from 5 to 300 kw., either direct or alternating current, has recently put on the market the Terry Type C H S, 3600 r.p.m. turbo-generator. This set is correct for the purpose for which it is furnished. It should be noted that the bearings are supported from the base and close together, thus there is no expansion and change of alinement. The construction is costly all the way



TERRY TYPE C H S TURBO-ALTERNATOR

through, but such as the builders consider proper where high speed is used. The casing is hung from the center and is split horizontally, as is the case with all Terry turbines. This means that alinement, steam connections, bearings, etc., are not disturbed to open casing, which can consequently safely be done by user if necessary. The equipment includes emergency governor and steam strainer. A rugged self-contained forced feed lubrication system is used.

SUPERIOR STEAM TRAPS

CONDENSATION from heating coils, radiators and tanks of various kinds must be removed continuously in order to get the best results. Traps to accomplish this in the best manner must remove the air as fast as it accumulates and must avoid the discharge of steam.

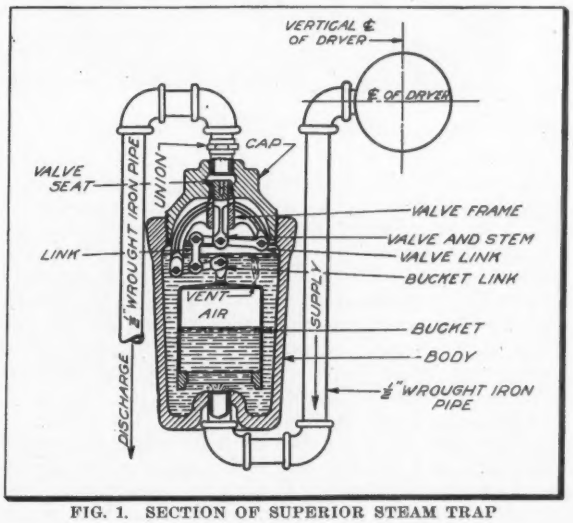


FIG. 1. SECTION OF SUPERIOR STEAM TRAP

The Superior trap has the inlet in the center of the bottom, as shown in the sectional view Fig. 1, directly beneath an inverted bucket. This bucket hangs on a pivot from a system of compound levers which operate the valve, this valve being located at

the highest point. The weight of the bucket, which, as shown, is of the inverted type, carries it downward, leaving the valve wide open.

The bottom of the bucket has feet, so that it leaves an open joint between the bucket and the bottom of the trap; the water entering through the inlet flows around the bucket, filling the body of the trap as well as the bucket. The trap is, therefore, filled with water clear to the top, and so long as water continues to enter it will flow out through the valve to the discharge. When steam enters the trap, it rises through the water into the top of the bucket and displaces the water in the bucket. After a sufficient amount has accumulated, the buoyancy of the empty bucket will cause it to rise quickly through the full range of its motion, which is about one inch, thus closing the outlet valve. Air will act the same as steam in causing the bucket to rise.

There is, however, in the top of the bucket a small air vent through which air or other incondensible gases will bubble out and rise into the top of the trap. When the accumulated steam has been condensed and the steam and air have bubbled out of the bucket so that the buoyancy has disappeared, the bucket will drop and as air and other gases are in the top of the trap, they will be discharged first, after which the water will again go on discharging until further accumulation of air or steam causes the bucket to rise, closing the outlet valve. By this arrangement sediment and foreign matter are kept at the bottom of the trap, away from the valve, air is drawn off from the top so that air-binding cannot occur, no packing is necessary in the trap and vacuum may readily be maintained in the discharge pipe.

The trap is made in 2 sizes, for ½-in. connections and for 1 or 1¼-in. connections, the smaller trap being suitable for operation under 50 lb. pressure and the larger under 120 lb. pressure. The Superior trap is manufactured by the Armstrong Machine Works, of Three Rivers, Mich.

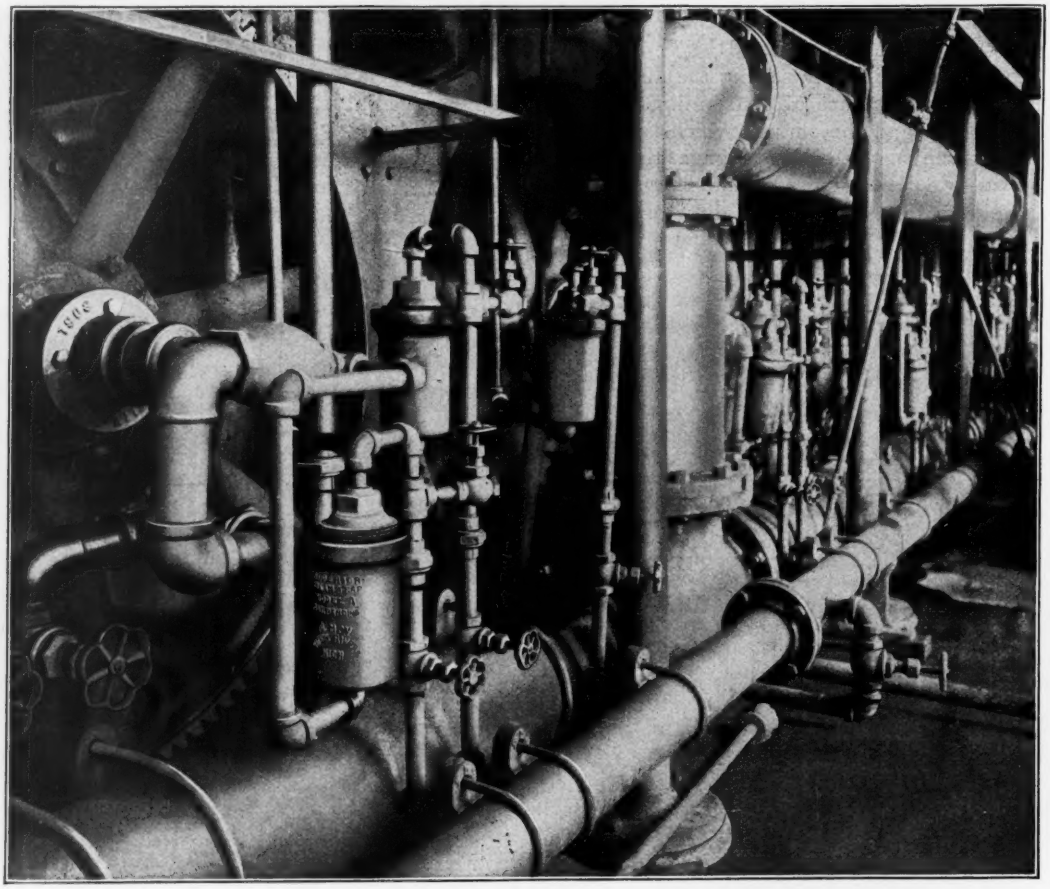


FIG. 2. PORTION OF SUPERIOR TRAP INSTALLATION ON PAPER MILL DRYERS

CYCLONE CLEANER FOR LOCOMOTIVE ARCH TUBES

BRICK arches in the furnaces of locomotive boilers are coming into favor, because of the increase in capacity and efficiency secured by their use. A difficulty encountered is the cleaning of the curved tubes, but this has been met by a special design of Liberty tube cleaner, called the Cyclone.

The motor of this machine has an outer casing in which is a removable, hardened steel cylinder, carrying inside a shaft mounted eccentrically with longitudinal slot in which a pair of semibalanced blades reciprocate. Provision is made for taking up wear automatically, to give a tight joint between the edges of the blades and cylinder wall. Reversible plates are

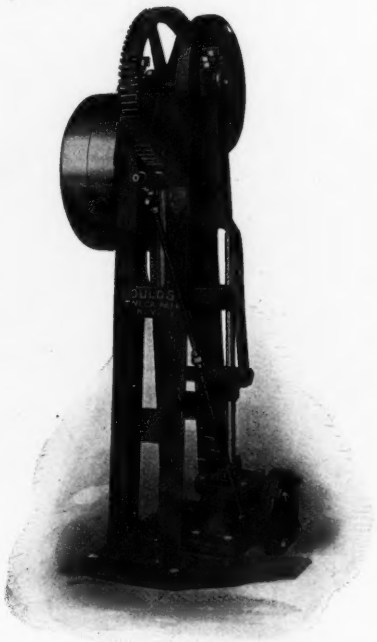
used to close the ends of cylinders, which can be turned when they become slightly worn, thus giving a new surface to insure a tight joint.

The cleaner is operated by from 60 to 75 lb. air pressure, using 45 to 50 cu. ft. of free air a minute. Two styles of head are used; one for heavy scale, the other a 2-arm head for use in 2½-in. tubes equipped with star wheel cutters. For special work the water turbine may be used, made on the lines of the L-B standard cleaner. Both designs are made by the Liberty Manufacturing Co., of Pittsburgh, Pa.

GOULDS NEW DEEP WELL POWER WORKING HEAD

For Pneumatic Water Supply Systems

THE illustration shows a new power working head The Goulds Mfg. Co. has just developed for operating cylinders in deep wells in connection with pneumatic pressure water supply systems. The new feature of this working head is that in addition to pumping the water from the well, it also supplies the air pressure for the tank.



GOULDS NEW DEEP WELL PUMP HEAD

Compressed air is supplied by a special air cylinder which is mounted on the frame near the top. The plunger of this air compressor is operated by a rod which is connected to the pitman of the working head by an extension of the pin connecting the pitman to the well rod. A pipe from the air cylinder connects it with the discharge of the working head. This air pipe contains a check valve and the necessary couplings. A cock is provided so that the air will not go to the tank when it is open and the outfit is relieved of this pressure when it is not needed.

The air cylinder, suction valve and discharge valve are made of brass and the plunger is leather cupped packed.

The well cover is located at the base, so that by taking out the bolts which secure it to the frame and disconnecting the well rod, the plunger can be withdrawn from the well without disturbing pipe connections or moving the working head. All bearings are split, babbited, provided with oil cups, and are adjustable. Any artesian and tubular well cylinders can be used in connection with this head, and it can be supplied with an air chamber where desired.

The stroke is adjustable 6, 8 or 10 in.; the maximum sizes of pipe for which it is supplied are 5 in. suction and 3 in. discharge. The gear ratio is 5 to 1 and the tight and loose pulleys supplied are 16 by 3 in. It will lift and force as follows: 2¼ in. cyl., 300 ft.; 2¾ in. cyl., 200 ft.; 3¼ in. cyl., 150 ft.; 3¾ in. cyl., 110 ft.; 4¼ in. cyl., 85 ft.

The outfit weighs about 375 lb., and it is suitable for belt drive with electric motor, gasoline engine or other power drive.

TOLEDO CENTER FINDER

IN laying out pipe lines and determining the lengths of runs between fittings, it is always desirable to know exactly the center measurement of the fitting from the end into which the pipe is to make up. To get this accurately with any ordinary rule is a nuisance and largely inaccurate. If the center distances are short, a distance of ⅛ in. in the measurement may make great difficulty in making up the line.

THE TOLEDO CENTER FINDER IN USE

The Toledo center finder is a device for use with an ordinary steel carpenter's square, to determine accurately the center measurement of any fitting. It covers a range of sizes from one inch to 6 in., and works as shown by the illustration, giving the results with absolute accuracy. Each straight edge of the center finder is graduated, one edge in sixteenths, one in eighths and one in quarters of an inch. The cross brace of the finder forms an arc of a circle and serves as a protractor graduated to angles of 5 deg. The device thus serves not only as a center finder, but for making accurate measurements, for striking correct angles and inclinations, in laying out piping, and for setting calipers or compasses to sizes within its capacity.

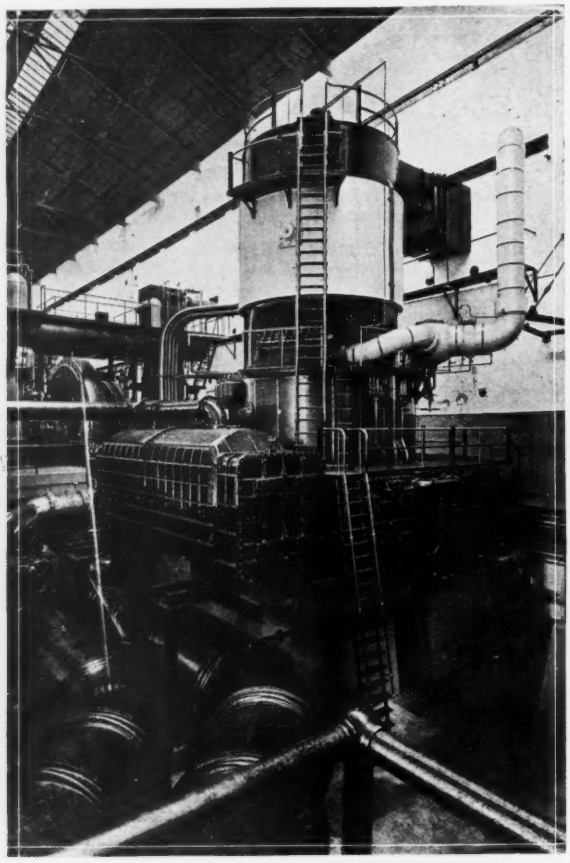
Hold the fitting against the wide leg of the square, and push up against the finder as shown until the finder centers. The pointer on the finder shows accurately the distance from center to end.

This device is made by the Toledo Pipe Threading Machine Co., of Toledo, Ohio.

BASE CONDENSER FOR 14,000-K. W. TURBINE

DEMAND for electric power for all purposes has grown enormously in all centers of population on the Pacific Coast, and has resulted in a rapid increase in the size of the power stations in all the large cities. The illustration shows the first turbine installed in Station A of the San Francisco Gas & Electric Co.

Previous to the purchase of the turbine the equipment of the station consisted of 10 1500-kw. triple-expansion condensing engines. The station load increased until it was beyond the capacity of the engines during the winter months; a dry year followed, and the hydro-electric plants with which the system is connected could not be relied upon. It was therefore



14,000-KW. CURTIS TURBINE WITH WHEELER CONDENSER AND ENGINEERING CO. CONDENSER AS THE BASE

decided to install an additional unit, of sufficient size to carry the extra load and to serve as a relay unit to the water power plant. On account of the capacity required, another engine unit was out of the question, and it was found that a 14,000-kw. vertical Curtis turbine, manufactured by the General Electric Co., would meet the requirements of the limited space available.

The condensing equipment offered a more serious problem, as the floor space required for a separate condenser could not be obtained. The solution was provided by the Wheeler Condenser & Engineering Co., who built a "dry tube" condenser into the base of the turbine as illustrated. The exhaust steam from the turbine flows directly down against the tubes. In addition there is a Wheeler wing auxiliary, as the base is not of sufficient size to hold all the tube surface necessary. An idea of the condenser tubing required may be obtained from the fact that 6000 18-gage tubes were necessary, the total weight of tubes alone being 25 tons, and if placed end to end they would extend for 19 miles. In the top base section is a Wheeler-Volz heater, through which the condensate is pumped, thereby gaining heat from the exhaust steam before passing to the secondary heaters.

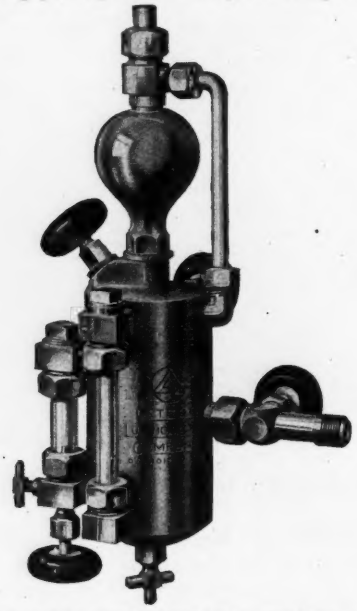
The circulating pumps are of the centrifugal type, capable of delivering 36,000,000 gal. of water per day, which is more than the average daily water consumption of the whole city of San Francisco. The dry vacuum and hotwell pumps are also of Wheeler make, and were especially designed for this installation.

As to its performance, the unit has been eminently satisfactory. The turbine delivers an amount of power equal to the combined output of the 10 engines while requiring less floor space than one engine unit. The fuel oil bill has dropped 33⅓ per cent, the repair and maintenance 25 per cent, and the labor 14 per cent. The condenser, guaranteed to maintain a vacuum of 28.4 in. has shown 29 in. and over for continued periods of service.

DETROIT GREASE LUBRICATOR

THE new Detroit "300" grease lubricator has recently been developed for the purpose of feeding grease, non-fluid oils and similar lubricants evenly, economically and efficiently.

The "300" grease lubricator is the same in construction as the Detroit Improved Standard except that it has a heating passage and a large heating chamber.



DETROIT "300" LUBRICATOR FOR FEEDING GREASE

This heating chamber is of sufficient size to reduce all the lubricant in the reservoir to a thoroughly liquid condition immediately after steam is turned on. No time is lost in waiting for the lubricator to warm up preparatory to feeding.

Cold drafts, outside exposure or temperature variations cannot affect the operation of the Detroit "300" in any way. The oil or grease in every part of the lubricator is maintained in a fluid condition at all times

with an even rate of feed, fine regulation, and maximum economy as results.

The "300" lubricator can be installed either with both connections between the boiler and the throttle or else with the condensing tube above the throttle and the delivery or support arm below the throttle. In order to permit of either installation, there is attached to each lubricator, properly tagged with complete instructions, a choke to be screwed into the support arm in case the connections are made on both sides of the throttle. If both connections are above the throttle, the choke is not required. The Detroit Lubricator Co. is the manufacturer of this new grease feeding device.

SIMONDS COMPOUND SYSTEM

Operating Pressure and Vacuum in the Radiators Through the Automatic Vacuum Valve

IN the Simonds compound system 2 sections of radiators or coils are used, one being termed the "primary or pressure" section, and the other the "secondary or vacuum" section. The primary section is supplied with steam and its return connected to the automatic vacuum valve, as shown in Fig. 1.

Water discharges from the vacuum valve into the secondary section, where a portion of it is re-evaporated, owing to the lower pressure maintained in this section. After condensing again, it passes to the vacuum pump through the return line. No valves are used on the inlet or outlet of the secondary section, which acts as a surface condenser. It has been found that when operating under atmospheric pressure in the steam main, or ¼ lb. above, and with 8 to 10 in. of vacuum in the returns, the secondary radiator can be half as large as the primary, and this proportion is used in such practice.

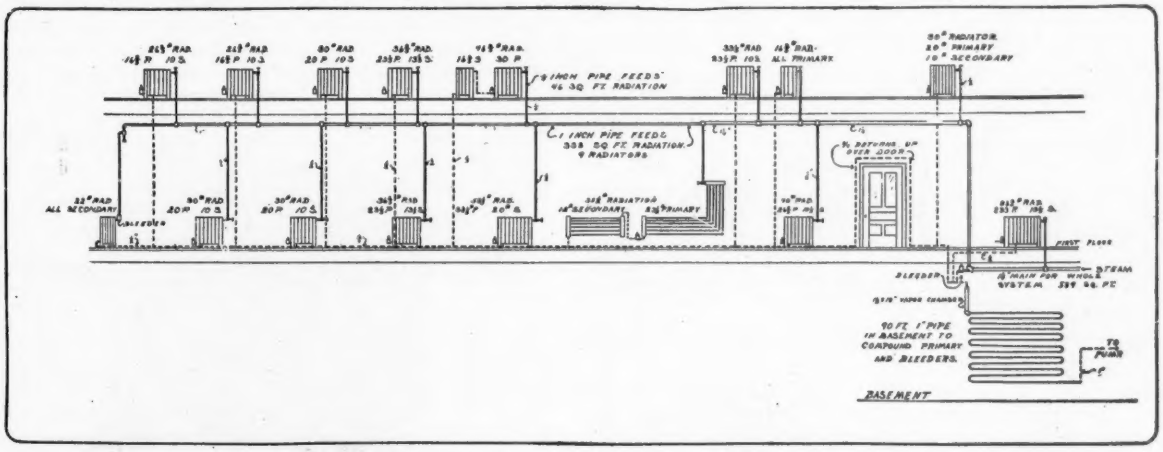


FIG. 1. TYPICAL CONNECTIONS FOR RADIATORS IN SIMONDS COMPOUND SYSTEM

Vacuum Valve

THE Simonds automatic vacuum valve, Fig. 2, is an automatic device operated by a float, and perfectly balanced by reason of an upper air discharge valve of the same unbalanced area as the lower one for water discharge. It will operate under any moderate steam pressure or any degree of vacuum.

The vacuum of the return line extends through the hollow stem to the upper float chamber and valve. The air that is carried along with the water of condensation naturally collects above the water in the dome case; and until sufficient water accumulates in the case to float the valves off, both are tightly seated.

When the float rises, the lower valve discharges the water, and the air passes through the upper valve and is drawn down through the tube that forms the stem to which both valves and the float are fastened, into the return line.

By means of the clamp upper valve, both valves can be adjusted tight on their respective seats after steam has been blown through them and all expansion has taken place.

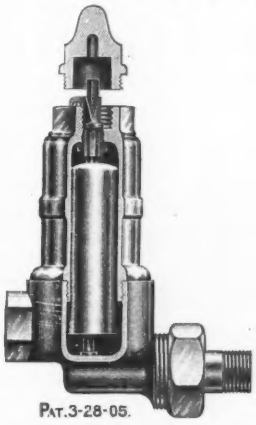


FIG. 2. THE SIMONDS AUTOMATIC VACUUM VALVE

The lower valve has no guide wings or pins to catch the scale and extraneous matter coming along with the water, therefore when off its seat gives free discharge; thus trouble from clogging, is reduced to the minimum on the natural principle that the greater the area of an opening the larger the substance necessary to choke clear egress.

As no dirt or foreign matter can get above the water line, there is no possibility of the vent of the upper valve fouling. After adjustment on its seat, no further attention is needed.

As to heat regulation, it is pointed out that as all air and water are constantly removed by the vacuum pump, without dependence upon the steam pressure, the steam inlet valve to the coil or radiator may be opened sufficiently to heat as much or little of the surface as desired, and this amount of surface only will be heated as long as those conditions exist. As may be conceived, such flexibility makes for steam economy, at the same time accommodating the needs of the occupant.

THE LEE CRANKPIN RETURNING MACHINE

THIS machine is for portable work in the engine room, the construction being such that it can be adjusted perfectly, that is, centered with the crankpin and parallel with the center line of the shaft.

Figure 1 shows a sectional view of the tool in position. The stud C is first screwed into the crankpin R, which holds the pilot cylinder D in place. The pilot is then placed over the bolt C and is held in position by the nut B. The tram collar X is then

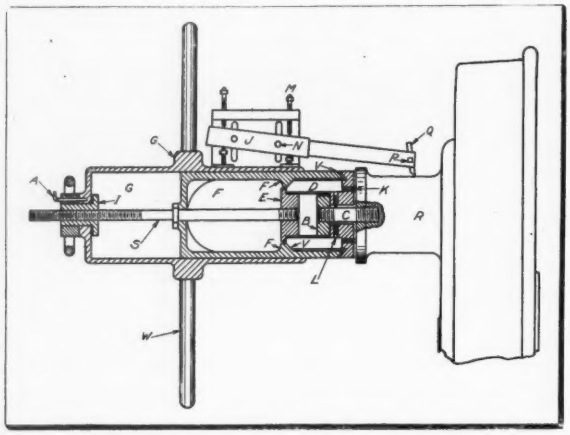


FIG. 1. THE LEE CRANKPIN RETURNING MACHINE IN POSITION TO WORK

placed over the pilot D, and the tram Z adjusted, and by means of this pilot D is shifted by screws L until it centers with the pin R. The pilot D is then leveled so as to come parallel with the axis of the shaft by means of the leveling screws K in the base of the pilot. This is done by leveling up the pilot in 4 positions of the crankpin, thus bringing it level with the shaft position. The shaft should, of course, be first leveled up to make sure that the pin will be parallel to it when turned.

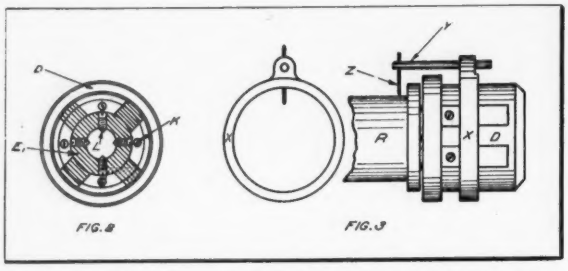


FIG. 2. CROSS-SECTION OF THE PILOT AND STEADY REST
FIG. 3. ARRANGEMENT OF THE GRAMMING DEVICE ON THE PILOT

Tighten nut B and we are ready to place in position the slide rest on the machine, which is shown at F in Fig. 1. This is held against ground taper joints V by a long bolt S, which is also threaded on the outer end, for the feed screw to move the shell G which carries the tool bar J. This tool bar is held in position on the slide rest by 2 screws N, and is adjusted for cut by the adjusting screws M. The feed device is a simple revolving nut disk 1, upon which is a band wheel H, which adjusts the tool into the cut. After this, the feed pin A can be pushed into a hole in the frame, or slide G, and by rotating the handle W, the machine will feed the cut across the pin at the same time that it is revolved, thus doing an accurate job of returning.

This machine is manufactured by the Hartford Engine Works, of Hartford, Conn., and is the invention of H. K. Lee, of that organization.

COAL DELIVERY BY MOTOR-DRIVEN HOPPERS

MOTOR-DRIVEN coal hoppers, which can take coal from bunkers located anywhere and deliver it to any boiler in a battery, are coming more and more into favor. Their use does away with the system of overhead bunkers and individual chutes for each boiler, and permits all the coal to be concentrated in one bunker instead of in a series of pockets.

The bunkers can be placed at one end of the boiler room, or, for that matter, outside if necessary, so that the boiler room can be designed and located with greater freedom, and plenty of space can be left above the boilers for light and air.

This system is not liable to break down, low in first cost, and avoids difficulty of taking care of surplus or overflow after intermediate discharge gates in a long run over distributed bunkers are closed.

The hopper runs on a trackway parallel to the front of the boilers and is controlled by an operator in the same manner as an overhead crane. Accurate scales on the hopper make it possible to keep a pre-

MOTOR-DRIVEN COAL HOPPER FOR FEEDING BOILERS

cise record of the fuel burned by any boiler. If desired, a recording device can be installed so that a printed record of the weight of every discharge can be made by the operator. The hopper runs under the bunker and is filled by the operator, the scales indicating when the hopper is full. It is then run into the boiler room and delivers coal where wanted.

The hoppers, which are manufactured by the Bergen Point Iron Works, Bayonne, N. J., are propelled by Westinghouse motors.

BADGER SELF-EQUALIZING EXPANSION JOINT

THE Badger self-equalizing expansion joint is a corrugated copper joint having external rings, and is designed to take up changes in length in pipe lines, whether these pipe lines convey steam, water, or air. Probably every engineer has experienced the irresistible strains in pipe lines caused by expansion and contraction. Loose, leaky fittings and

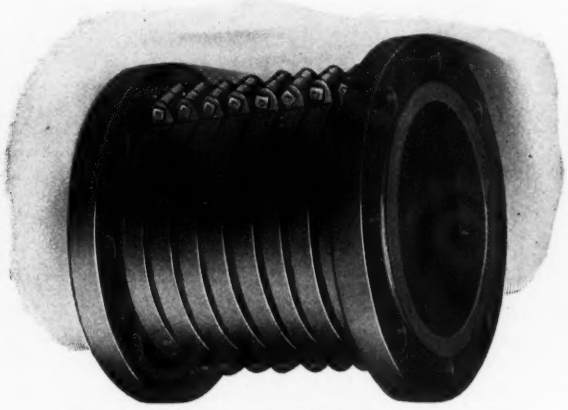


FIG. 1. BADGER EXPANSION JOINT COMPLETE

perhaps here and there a fractured joint point conclusively to the necessity for some device having sufficient flexibility to absorb these changes. The engineer also knows that the amount of change in pipe length depends upon 2 factors, the pipe length and the difference in temperature.

Although bends and long sweeps or loops are useful in making changes in direction and have been used quite extensively for taking care of changes in length,

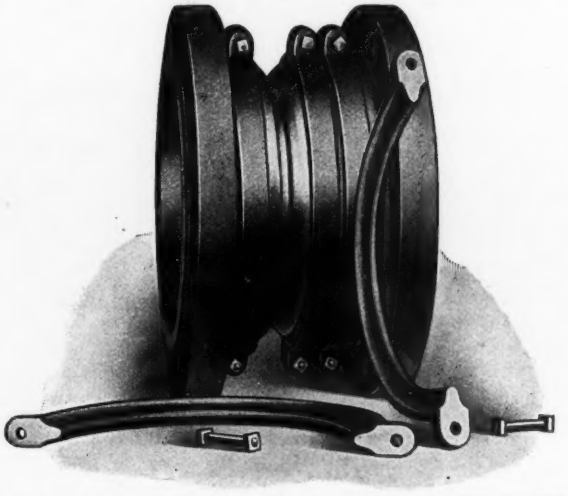


FIG. 2. BADGER EXPANSION JOINT WITH 1 EXTERNAL RING REMOVED

they take up considerable valuable space, also cracks are liable to develop under repeated temperature changes. The slip joint has the one disadvantage of requiring frequent packing.

The Badger joint combines the elasticity to stand repeated changes of shape and strength to resist any pressure for which the joint is designed. The corrugated form, such as used for furnaces of internally fired boilers, is adopted because of its strength and flexibility. But a single piece of copper with corrugations would have to be very thick for high pressures and in actual practice it is found that there is always a tendency for 1 or 2 corrugations to take the entire strain of repeated changes in shape. In time these few corrugations taking all the work would give out. External rings on the corrugations of the Badger joint distribute the strains among several corrugations and by thus bringing many corrugations into service no one of them is called upon to take more than its share of the work. The external rings force a part of the strain to the next corrugation and as each corrugation has but slight movement the joint lasts almost indefinitely. The external rings give added strength to the joint in the same way that spiral winding of a pipe with wire adds to its strength.

The number of corrugations depends upon the pressure and upon the length of the joint. For high pressures and superheated steam the change in length is considerable, therefore more corrugations are used. For very low pressures as in exhaust piping 2 or 3 corrugations are sufficient for the slight alteration in length. There are even some cases where the expansion is so little, but vibration must be taken up, that the joint does not need any external rings. But in most cases external rings are used both to add strength for high pressure and also to stiffen the exhaust pipe against collapse.

The Badger expansion joint, which is made by the E. B. Badger & Sons Co., 63-75 Pitts St., Boston, is made in a complete line of sizes for all pressures and with flanges drilled to A. S. M. E. standards, both high pressure and extra heavy pressure. These joints require no packing and take up no more room than a pipe fitting. For low-pressure work they have been made up to 6 ft. in diameter and have been made oval, rectangular, circular, and in special forms.

PLANS FOR A $1,000,000 COLD STORAGE plant on the new Fish Pier at South Boston, Mass., have been completed. The plant, which will probably be ready for use by April, 1914, will be called the Commonwealth Ice and Cold Storage Plant, and it will be equipped with the largest ice plant in the city. Members of the Boston Fish Market Corporation will be the stockholders in this new enterprise. Upon the completion of the building Boston will have the biggest fish plant in the world, the total cost of which will probably exceed $3,000,000.

The building is to be of steel and concrete construction, with a frontage of 220 ft. on Northern Ave. and extending back on the pier 252 ft. It will have 8 stories, giving a height of 91 ft. At the rear a power station will adjoin the main building. The ice-making capacity will be 180 tons a day and the power plant will generate electricity to light and heat all the buildings on the pier, 5 in all, each with about 100 stores. The main building is to have 1,500,000 cu. ft. of cold storage space and room for 6000 tons of ice. It is probable that about one-half of the storage space will be required for the fish trade, while the remainder can be used for general business purposes.

SENIORS IN the electrical engineering department of the University of Missouri, at Columbia, have been intrusted with the task of drawing plans for a new electrical power plant which the university has arranged to erect. The plant will be of 1600 hp. and will be one of the most modern that can be provided.

BOOKS AND CATALOGS

THE BUREAU OF MINES has copies of the following publications for free distribution, but can not give more than one copy of the same bulletin to one person:

Bulletin 48. Selection of explosives used in engineering and mining operations, by Clarence Hall and S. P. Howell. 1913. 50 pp.

Bulletin 55. The commercial trend of the gas producer in the United States, by R. H. Fernald. 1913. 92 pp.

Bulletin 62. National Mine-Rescue and First-Aid Conference, Pittsburgh, Pa., September 23-26, 1912, by H. M. Wilson. 1913. 74 pp.

Technical Paper 38. Wastes in the production and utilization of natural gas, and means for their prevention, by Ralph Arnold and F. G. Clapp. 1913. 29 pp.

Technical Paper 48. Coal-mine accidents in the United States, 1896-1912, with monthly statistics for 1912, compiled by F. W. Horton. 1913. 72 pp.

Requests for all papers can not be granted without satisfactory reason. In asking for publications please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

THE PROPERTIES OF Saturated and Superheated Ammonia Vapor, by Professor G. A. Goodenough and Mr. W. E. Mosher, has been issued as Bulletin No. 66 of the Engineering Experiment Station of the University of Illinois.

The increasing importance of mechanical refrigeration makes an accurate knowledge of the properties of refrigerating fluids extremely desirable. The experimental data on the most important of these fluids, ammonia, are meager and somewhat discordant, and tables of the properties of ammonia that have heretofore been used are known to be quite inaccurate in many particulars. The authors of this bulletin have analyzed the available data and have worked out tables of the properties of both saturated and superheated ammonia that probably represent most accurately the present knowledge of the subject. A convenient chart, with directions for use, gives an easy means for solving graphically the usual practical problems met in refrigeration practice. Copies of Bulletin No. 66 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

COMPLETE BULLETIN of the American School of Correspondence, 58th St. and Drexel Ave., Chicago, has recently been issued.

FROM AMERICAN MFG. CO., Noble and West Sts., Brooklyn, New York, we have received a circular relating to manila rope.

A WALL MAP of the Panama Canal and Canal Zone, with some Canal data, was recently received from Peerless Rubber Mfg. Co., 16 Warren St., New York.

THE NEW BRISTOL set-back counter, a patented device which can be quickly and easily set back to zero position, is described and illustrated in Bulletin No. 169 from the Bristol Co., Waterbury, Conn.

AMERICAN WIRE WHEEL News, published by American Steel & Wire Co., 72 W. Adams St., Chicago, has recently been received. It contains an account of the art of making wire wheels for automobile use. A pendulum test of wire and wooden wheels, which was conducted in an English factory, is described.

AN AIR WASHER particularly adapted to meet the requirement of economy of space and described as having a driving power equal in some instances to 50 per cent efficiency is the subject of an illustrated bulletin, No. 51, from Spray Engineering Co., 201 Devonshire St., Boston, Mass.

MESTA BLOWING ENGINES is the title of a pamphlet recently issued by the Mesta Machine Co., Pittsburgh, Pa., which describes a new valve for the air end of blast furnace engines. The valve is equally well adapted to compressors. A copy of the pamphlet may be had upon request to the above company.

GARDNER-RIX vertical air compressors are described in Circular GR-2, recently received from the Gardner Governor Co., Quincy, Ill. The compressors are built for belt or gear drive, and may be furnished for stationary or portable installations. The catalog gives a complete technical description, as well as tables of dimensions and capacities.

"CIRCULATION OF WATER in Steam Boilers" is the title of a pamphlet recently issued by E. T. Copeland Company, 100 William St., New York. The pamphlet first gives the theory of circulation, then describes the Copeland patent automatic circulating system which is particularly adapted for increasing the circulation in Scotch boilers.

GENERAL CATALOG No. 19 has just been issued by the U. S. Graphite Co. of Saginaw, Mich., describing the many products which are made from Mexican flake graphite. These include lubricating graphite, graphite greases, driving chain graphite, polishing graphite, etc. The catalog is well illustrated and may be had, upon request, from the manufacturers.

IRRIGATION FACTS are given and various types of Goulds irrigation pumps used to meet the different conditions found in irrigation service are described and illustrated in a catalog recently issued by the Goulds Manufacturing Co., Seneca Falls, N. Y.

A pamphlet from the same company shows a few typical pumps and gives a list of publications on power pumps for all services.

UNDER THE HEADING, "Central Station Oil Switches," the General Electric Co. has issued bulletin No. A-4114, containing preliminary information on that company's oil switches, known as Type F, Form K-21, which are used on systems of voltages up to 110,000. The construction of the switches is shown in detail, and the various operating mechanisms illustrated and described.

BULLETIN A-4097, recently issued by the General Electric Co., describes in considerable detail that company's ventilated motors for railway service. The fundamental difference between this and previous types of railway motor lies in the method of cooling. In these motors is a definite longitudinal circulation of air through the whole interior of the motor, which cools all the interior parts to an extent heretofore impossible, and effects a considerable increase in service capacity.

These motors can be operated as fully ventilated, semi-ventilated, or fully inclosed motors. The definite air circulation is accomplished by means of a fan which is an integral part of the armature head, in conjunction with longitudinal ducts through the interior of the commutator and armature core. All sizes are regularly furnished with a box frame, but the smaller and medium sizes can be furnished with a slit frame if desired.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

Tests of high-pressure simple expansion locomobiles using superheated steam in European plants.

Plant	Date of Test	Brake Horse-power	Steam Temper. Deg. F.	Steam per B.H.B. hr., lb.	Coal per B.H.P. hr., lb.
Fr. Bruns	2–10–08	19.35	.....	20.17	2.29
Lindener Brewery Co.	28–3–06	19.70	.....	19.40	2.47
Jos. Klaus	10–4–08	22.20	.....	20.28	2.38
B. Rietsch	9–9–08	26.3	593.6	19.31	2.29
J. A. Lezi	27–4–08	29.2	611.6	19.51	3.00
Town of Zerno-witz	30–10–07	32.7	584.6	(100.80 B.t.u.) 19.47	2.20
G. S. Davidsohn	12–10–06	34.2	548.6	19.84	2.29
C. Simmerl	27–5–07	53.6	590.0	18.59	2.25
J. Holazek	13–2–09	51.3	595.4	18.96	2.14
Count Hatzfeld	2–3–09	63.35	597.2	18.30	2.09
H. Thielcke & Sohn	14–6–07	75.90	582.8	18.01	2.07
Kreuzau Paper Mills	28–9–07	87.20	591.8	18.12	2.05
Firebrick Works, Gleiwitz	22–1–07	122.20	588.2	17.06	2.06
A. Wohlfeld	27–7–08	146.50	608.0	16.09	1.976

PRACTICAL ENGINEER

SPACINGS AND CLEARANCES FOR CONDUIT

For value of E see table of dimensions of conduit nipples
For C = ⅝ in. A and B are as shown in table in inches

Size Conduit		½	¾	1	1¼	1½	2	2½	3	3½
½	A	1⅜	1⅜	2	2 5/16	2 5/16	2⅜	2 11/16	3⅛	3⅜
	B	0.91	0.93	0.92	0.93	0.94	1.02	1.08	1.08	1.14
¾	A	1⅜	2	2⅛	2 5/16	2 5/16	2⅜	3 1/16	3⅜	3⅜
	B	0.93	0.95	0.94	0.96	0.96	1.04	1.10	1.10	1.17
1	A	2	2⅛	2⅛	2 5/16	2 5/16	2⅜	3 5/16	3⅜	3⅜
	B	0.92	0.94	0.94	0.96	0.96	1.03	1.10	1.10	1.16
1¼	A	2 5/16	2 5/16	7/16	2⅜	2⅜	3 1/16	3⅜	3⅜	4 1/16
	B	0.93	0.96	0.96	0.96	0.97	1.05	1.12	1.17	1.24
1½	A	2 5/16	2 7/16	2 5/16	2⅜	2⅜	3 5/16	3⅜	4	4 5/16
	B	0.94	0.96	0.96	0.97	0.97	1.06	1.11	1.17	1.24
2	A	2⅜	2⅜	2⅜	3 1/16	3 5/16	3⅜	3 11/16	4⅛	4⅛
	B	1.02	1.04	1.03	1.05	1.05	1.13	1.13	1.19	1.32
2½	A	2 11/16	3 1/16	3 1/16	3⅜	3⅜	3 11/16	4⅛	4⅛	4 11/16
	B	1.08	1.10	1.10	1.11	1.12	1.19	1.26	1.26	1.39
3	A	3⅛	3⅜	3⅜	3⅜	4	4⅛	4⅛	4 11/16	5⅛
	B	1.08	1.10	1.10	1.17	1.17	1.19	1.24	1.24	1.44
3½	A	3⅜	3⅜	3⅜	4 1/16	4 5/16	4⅛	4 11/16	5⅛	5⅛
	B	1.14	1.17	1.16	1.24	1.24	1.32	1.39	1.44	1.56

PRACTICAL ENGINEER

WIRE CAPACITY OF UNLINED WROUGHT IRON CONDUIT.

For Short, Medium and Long Runs.

The table shows the number of double-braid, rubber-insulated wires that can be pulled into conduits of wrought iron pipe sizes. Wire smaller than No. 6 is solid. No. 6 and larger is stranded.

A Short Run is one that is not over 150 ft. in length and is almost straight, but it may have 1 or 2 bends of a radius not less than 3 feet. Good conditions for pulling and feeding wire are assumed.

A Medium Run is one that does not exceed 150 ft. in length and has not more than 3 or 4 easy bends; or it may be 250 ft. long and nearly straight or it may be a short run with 1 close bend and 1 or 2 easy ones.

A Long Run is one of a length exceeding 150 ft., with close or medium bends; or any run with more than 1 close bend; or any run with an extra close bend.

Table I indicates about the minimum and maximum limits. No conduit smaller than ½ in. is permitted for electric light or power wiring, but ⅜-in. conduit is sometimes used for signal work, hence is tabulated. No smaller wire than No. 14 is permitted for light or power, but smaller ones are used for signal work.

Table II gives values for medium runs, that is, average runs as defined above. Where runs are short or have few turns, smaller conduit can be used than for long runs with several sharp turns.

PRACTICAL ENGINEER

TABLE II. WIRE CAPACITY OF CONDUIT—MEDIUM RUNS

Size Wire		Circular Mils.	Safe Carrying Capacity. Rubber Insulation	Weather Proof	Diam. Rubb. Insul. Double Braid in 32ds. inch.	Size of Unlined, Wrought Iron Conduit for 0-600 Volts, Rubber-Insulated, Double-Braid Wires. Permissible Number of Wires in One Conduit																
	B. & S. Gage					1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	21	
Stranded.	0000	211,600	210	312	28	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	000	167,800	177	262	26	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	00	133,100	150	220	24	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	0	105,500	127	185	23	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	1	83,690	107	156	21	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	2	66,370	90	131	19	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	3	52,630	76	110	17	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	4	41,740	65	92	16	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	5	33,100	54	77	15	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	6	26,250	46	65	14	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
Solid.	8	16,510	33	46	11	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	10	10,380	24	32	10	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	12	6,530	17	23	9	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	14	4,107	12	16	8	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	16	2,583	6	8	7	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6
	18	1,624	3	5	6	1	2	2½	3	3	3½	3½	4	4	4	4½	5	5	5½	6	6	6

SPACINGS AND CLEARANCES FOR CONDUIT

For value of E see table of dimensions of conduit nipples
For C = ¾ in. A and B are as shown in table in inches

Size Conduit		½	¾	1	1¼	1½	2	2½	3	3½
½	A	1 7/16	2	2 1/16	2 1/16	2 7/16	2 13/16	3 1/16	3 5/16	3 5/16
	B	1.03	1.05	1.04	1.05	1.06	1.14	1.20	1.20	1.26
¾	A	2	2 1/16	2 1/16	2 7/16	2 7/16	2 13/16	3 1/16	3 5/16	3 5/16
	B	1.05	1.07	1.06	1.08	1.08	1.16	1.22	1.22	1.29
1	A	2 1/16	2 1/16	2 5/16	2 7/16	2 11/16	3	3 5/16	3 5/16	4
	B	1.04	1.06	1.06	1.08	1.08	1.15	1.22	1.22	1.35
1¼	A	2 5/16	2 7/16	2 5/16	2 13/16	2 13/16	3 5/16	3 5/16	3 5/16	4 5/16
	B	1.05	1.08	1.08	1.08	1.09	1.17	1.24	1.29	1.36
1½	A	2 7/16	2 5/16	2 11/16	2 13/16	3	3 5/16	3 5/16	4 5/16	4 5/16
	B	1.06	1.08	1.08	1.09	1.09	1.18	1.25	1.29	1.37
2	A	2 13/16	2 13/16	3	3 5/16	3 5/16	3 13/16	3 13/16	4 13/16	4 13/16
	B	1.14	1.16	1.15	1.17	1.18	1.25	1.25	1.31	1.45
2½	A	3 1/16	3 5/16	3 5/16	3 5/16	3 13/16	3 13/16	4 1/16	4 13/16	4 13/16
	B	1.20	1.22	1.22	1.23	1.24	1.31	1.38	1.38	1.51
3	A	3 13/16	3 13/16	3 13/16	3 13/16	4 13/16	4 13/16	4 13/16	5 1/16	5 13/16
	B	1.20	1.22	1.22	1.29	1.29	1.31	1.45	1.36	1.56
3½	A	3 13/16	3 13/16	4	4 5/16	4 5/16	4 13/16	4 13/16	5 13/16	5 13/16
	B	1.26	1.29	1.28	1.36	1.37	1.45	1.51	1.56	1.68

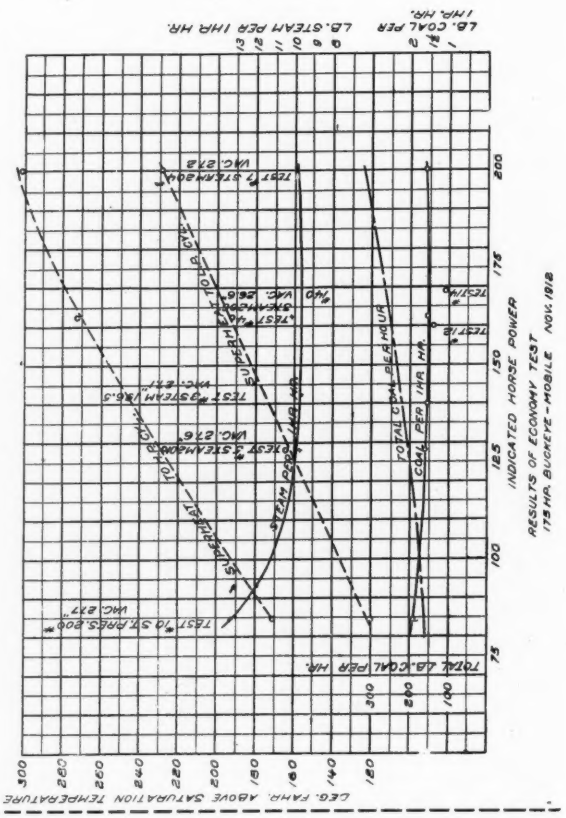

LB. COAL PER IHP. HR.
LB. STEAM PER IHP HR.
TEST 7 STEAM 204° VAC. 27.2
TEST 6 STEAM 204° VAC. 26.6
TEST 5 STEAM 204° VAC. 27.1
TEST 3 STEAM 196.5 VAC. 27.1
TEST 2 STEAM 196° VAC. 27.6
TEST 1 STEAM 209° VAC. 27.7
SUPERHEAT
STEAM PER IHP HR.
TOTAL COAL PER HOUR
COAL PER IHP HR.
TOTAL LB. COAL PER HR.
DEG. FAHR. ABOVE SATURATION TEMPERATURE
INDICATED HORSE POWER
RESULTS OF ECONOMY TEST
175 HP. BUCKEYE - MOBILE NOV. 1918

TABLE I
LIMITS OF WIRE TO BE PULLED INTO CONDUITS

Size Wire		SIZE OF CONDUIT, INCHES								
		1 Wire In Conduit			2 Wires In Conduit			3 Wires In Conduit		
B. & S. Gauge	Circular Mils	Short Run	Medium Run	Long Run	Short Run	Medium Run	Long Run	Short Run	Medium Run	Long Run
14	4,107									1
12	6,530									1
10	10,380								1	1
8	16,510						1	1	1¼	1¼
6	26,250				1	1	1¼	1	1¼	1½
4	41,740				1	1¼	1½	1¼	1½	2
3	52,630				1¼	1½	1½	1½	1½	2
2	66,370			1	1½	1½	2	1½	2	2
1	83,690		1	1	1½	2	2	2	2	2
0	105,500		1	1	2	2	2	2	2	2½
00	133,100	1	1	1	2	2	2	2	2½	2½
000	167,800	1	1¼	1¼	2	2	2½	2½	2½	3
0000	211,600	1	1¼	1½	2	2½	2½	2½	3	3
.....	300,000	1¼	1½	1½	2½	2½	3	3	3	3½
.....	400,000	1½	1½	2	2½	3	3	3½	3½	4
.....	500,000	2	2	2½	3	3	3½	4	4	4½
.....	700,000	2	2½	2½	3	3½	4	4½	4½	5
.....	1,000,000	2	2½	3	4	4	4½	5	5	6
.....	1,500,000	3	3	4	4½	4½	5	6	6	7
.....	2,000,000	3	3	4	6	6	7			

Size of Unlined, Wrought Iron Conduit for 0-600 Volts, Rubber-Insulated, Double-Braid Wires

Size Wire		Safe Carrying Capacity		Diam. Rubb. Insul. Double Braid in 32ds. Inch.	Permissible Number of Wires in One Conduit																			
B. & S. Gage	Circular Mils.	Rubber Insulation	Weather Proof		1	2	3	4	5	6	7	8	9	10	11 12	13 14	15 16	17 18	19	20 21
.....	250,000	235	350	30	1¼	2½	2½	3	3½	3½	4	4	4½	4½	5	5	6	6	6	
.....	300,000	270	400	32	1¼	2½	3	3	3½	4	4	4	4½	5	5	6	6	6		
.....	350,000	300	450	1" 2	1½	3	3	3½	4	4½	4½	4½	5	5	6	6	6			
.....	400,000	330	500	1" 3	1½	3	3	3½	4	4½	4½	5	5	6	6	6				
.....	450,000	360	545	1" 5	1½	3	3	3½	4	4½	5	5	6	6	6					
.....	500,000	390	590	1" 6	2	3	3½	4	4½	5	5	6	6							
.....	550,000	420	635	1" 8	2	3	3½	4	4½	5	5	6	6							
.....	600,000	450	680	1" 9	2	3½	4	4½	5	5	6	6	6							
.....	650,000	475	720	1" 11	2	3½	4	4½	5	6	6	6	6							
.....	700,000	500	760	1" 12	2½	3½	4	4½	5	6	6	6	6							
.....	750,000	525	800	1" 13	2½	3½	4	4½	5	6	6									
.....	800,000	550	840	1" 14	2½	3½	4	4½	5	6	6									
.....	850,000	575	880	1" 15	2½	3½	4	4½	5	6	6									
.....	900,000	600	920	1" 16	2½	4	4	4½	5	6	6									
.....	950,000	625	960	1" 17	2½	4	4½	5	6	6										
.....	1,000,000	650	1,000	1" 18	2½	4	4½	5	6	6										
.....	1,100,000	690	1,050	1" 20	2½	4½	5	6	6											
.....	1,200,000	730	1,150	1" 22	2½	4½	5	6	6											
.....	1,300,000	770	1,250	1" 24	3	4½	5	6	6											
.....	1,400,000	810	1,290	1" 25	3	4½	5	6	6											
.....	1,500,000	850	1,360	1" 27	3	4½	5	6												
.....	1,600,000	890	1,430	1" 28	3	5	6	6												
.....	1,700,000	930	1,490	1" 30	3	5	6	6												
.....	1,800,000	970	1,550	1" 31	3	5	6	6												
.....	1,900,000	1,010	1,610	1" 1	3	5	6	6												
.....	2,000,000	1,050	1,670	2" 2	3	5	6	6												

Table of Conduit Sizes for No. 14 B. & S. Duplex, Double Braided Cables for 0 to 600 Volts	
Size Conduit	No. of Duplex Cables Ordinary Runs
½	1
¾	2
1	3
1¼	6
1½	8
2	15

REFORM THERMOMETERS are designed to embody the accuracy of a standard glass thermometer and the advantages of a dial face instrument. A brief description is given in a circular from the Schaeffer & Budenberg Mfg. Co., 481 De Kalb Ave., Brooklyn, N. Y.

SPRAGUE CONDUIT PRODUCTS are described and illustrated in a 100-page catalog, No. 439, superseding all previous conduit price lists, which has recently been issued by Sprague Electric Works of General Electric Co., 527-531 West 34th St., New York.

A pamphlet describing Sprague electric equipments for printing machinery has been received from the same company.

ALL FAMOUS is the title of a rather unusual pamphlet which derives its title from the cover design formed by trade marks of companies using Heine boilers, surrounding the trade mark of the Heine Safety Boiler Co. The character and size of the boiler equipment in use by each company are indicated in some reprinted matter, also advantages of Heine Superheaters. Copies of this pamphlet may be obtained upon application to the Heine Safety Boiler Co., of St. Louis, Mo.

AN ATTRACTIVE BULLETIN, in colors, recently issued by the General Electric Co., is devoted to the subject of Edison Mazda sign lamps. The bulletin contains reproductions of photographs of signs of various styles and sizes located in different cities of the United States, describes different lamps used in connection with this method of advertising, illustrates various sign receptacles with which the lamps may be used, and altogether will be found interesting to business men in general. The number of the bulletin is A4072.

FROM THE UNITED STATES GRAPHITE CO., of Saginaw, Mich., comes a new catalog entitled "Graphite Products," which shows, in nearly 50 pages, the value of graphite for different industrial uses, and the different forms in which the Mexican graphite is prepared and conveniently put up for users. The products include boiler compounds, lubricants, paint, tight joint compound, and powdered graphite of various degrees of fineness, and the catalog, with full information, is available, together with special literature and information which may be desired, on request.

THE WHEELER CONDENSER & ENG. CO. is now distributing 2 interesting pamphlets, one on jet condensers and the other on surface condensers. The Jet Condenser Pamphlet consists essentially of an article entitled "Tests of Power Plant Apparatus," which covers tests on a Wheeler counter-current rain type jet condenser, with which comparatively high vacuums were obtained with warm condensing water.

The second pamphlet contains an article, "Tests of Large High Vacuum Condensers," giving data pertaining to tests of a large high vacuum condenser which was guaranteed to produce vacuums as high as 28.9 in. with 70 deg. cooling water. The tests show that the guarantees were exceeded. A number of drawings, photographs, charts and tables are included. The calculations of heat transmission show that as high as 550 B.t.u. per sq. ft. per hour per degree difference in temperature was obtained. An interesting chart gives the relation of heat on the centrifugal circulating pump and the capacity in gallons per minute. Copies of this booklet as well as the booklet mentioned above may be had on application to the Wheeler Condenser & Engineering Co., of Carteret, N. J., or any of its branch offices.

A NEW CIRCULAR from Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., describes and illustrates electric vehicle battery-charging switchboards and motor-generator sets.

Porcelain strain insulators are described in another circular from that company.

INTERNATIONAL STEAM PUMP CO., is sending out a catalog just issued by Henry R. Worthington, descriptive of Worthington centrifugal volute pumps.

From the same company we have received a new Spanish catalog issued by the Clayton Air Compressor Works, describing Clayton air compressors.

TRADE NOTES

THE VILTER MFG. CO. with offices at 972 Clinton St., Milwaukee, Wis., reports the following among recent sales:

Consumers Elec. Light & Refrigerating Co., Colon, Panama, 30-ton can ice-making plant and 25-ton refrigerating plant, ammonia compressor direct connected to 16 by 36-in. Corliss engine; North Packing & Provision Co., Boston, Mass., 300-ton refrigerating plant, condensers, etc., direct connected to cross compound Corliss engine; Peoria Packing Co., Peoria, Ill., 70-ton refrigerating plant; Harris Abattoir Co., Toronto, Ont., Can., 18-ton refrigerating machine; Wausau Brewing Co., Wausau, Wis., 35-ton refrigerating plant; Gottfried Brewing Co., Chicago, material for 25-ton can ice plant; Anheuser-Busch Brewing Association for Norfolk, Va., 250-ton refrigerating plant; Manitoba Cold Storage Co., Ltd., Winnipeg, Man., Can., 300-ton refrigerating machine and high pressure side; Interstate Cotton Oil Co., Sherman, Texas, 50-ton refrigerating machine; Fischer Artificial Ice & Cold Storage Co., Dubuque, Ia., 50-ton can ice plant.

THE MUNNING-LOEB CO. of Matawan, New Jersey, announces that it has obtained the exclusive rights for the manufacture and sale of the "None-Such" Single Cylinder and Double Cylinder Rotating Plating Barrel, covered by patents of S. D. Catlin and formerly sold by Rockhill & Vietor.

These machines are now being manufactured at the plant of the Munning-Loeb Co., and several new features have been incorporated. The decision of the Munning-Loeb Co. to manufacture the None-Such Plating Barrel was made only after an investigation of the different types on the market, which showed that the "None-Such" was the most efficient and practical barrel for plating small articles.

The Munning-Loeb Co. also announces that it has acquired the sale and manufacturing rights of the None-Such Carboy Rocker.

Both of these appliances are fully described in Catalog 400 which will soon be ready for distribution.

AMERICAN ENGINEERING CO., Philadelphia, announces that the following companies have recently purchased Taylor Stokers:—

N. Y., N. H. & Hartford R. R. Co., Coscob, Conn.; Narragansett Brewing Co., Providence, R. I.; General Electric Co., West Lynn, Mass.; Boston Woven Hose & Rubber Co., Boston, Mass.; Dominion Iron & Steel Co., Sydney, N. S.; American Brass Co., Waterbury, Conn.; Bay State Street Railway Co., Chelsea, Mass.; Tremont & Suffolk Mills, Lowell, Mass.; Cochrane Chemical Co., Boston, Mass.; Montreal Elec. Light & Power Co., Montreal, Canada.; United Illuminating Co., for both their New Haven & Bridgeport plants; Detroit Edison Co., Detroit, Mich.; Philadelphia Electric Co., Philadelphia, Pa.; Elmira Water, Light & Railroad Co., Elmira, New York.

RECENTLY 4 Sturtevant Fuel Economizers were shipped by the B. F. Sturtevant Co., to the Commonwealth Edison Co., Chicago, for unit No. 12 of the Fiske Street station, to be used in connection with 4 boilers, one machine for each boiler. Each machine consists of 528 pipes arranged in 3 groups. Induced draft will be provided for by 4 Sturtevant Multivane exhausters equipped with water cooled bearings and driven direct connected by 75-hp. induction motors. The fans discharge into a stack 19 ft., in diameter and 259½ ft. high above the boiler room floor. Each boiler contains 12,260 sq. ft. of water heating surface and 3000 sq. ft. of superheating surface. The boilers are equipped with 2 chain grate stokers containing 136 sq. ft. of surface each. Each boiler is capable of evaporating a maximum of 80,000 lb. of water an hour with feed water at 250 deg. F., into steam at 210 lb. pressure, 225 deg. superheat. About 13,000 lb. of Illinois slack coal will be burned an hour.

The flue connecting the economizer with the fan inlet is built of steel plate and fitted with 4 dampers each consisting of 3 cast-iron louvers. Eight induction motors are provided for driving the scraper mechanism, chain drive being used.

There are also being constructed now, or shipped recently by the Sturtevant Co., economizers for the Cleveland Illuminating Co., Southern California Edison Co., Delaware & Hudson R. R., Rochester Electric Light Railway Co., aggregating 31,200 hp.

WESTINGHOUSE ELECTRIC & MFG. CO. reports the following orders among those recently received:

Blackstone Valley Gas & Electric Co., through Stone & Webster, one 12,850-k.v.a., 2300-v., 3-phase, 60-cycle turbo generator, and 3 4300-k.v.a., 13,200/-2300-v., single-phase, 60-cycle, O. I. W. C. transformers; El Paso Electric Railway Co., El Paso, Texas, through Stone & Webster, 2 400-k.v.a., 6600/2300-v., single-phase, 60-cycle, O. I. S. C. transformers and one switchboard; Oakland, Antioch & Eastern Railway, San Francisco, Calif., one 750-kw. synchronous motor generator set consisting of one 11,000-v., 3-phase, 60-cycle motor and one 11,000-v., d.c. generator; The Pittsburgh Railways Co., Pittsburgh, Pa., one 500-kw., 600-v., d.c., 6-phase, 60-cycle, self-starting rotary converter and one 550-k.v.a., 22,000/rotary voltage, 3-phase, O. I. S. C., outdoor type transformers complete with one 2-panel switchboard; South Covington & Cincinnati Street Railway Co., Covington, Ky., one 300-kw. portable substation in which is installed one 300-kw., 600-v., d.c., 3-phase, 60-cycle, 1200 r.p.m., self-starting rotary converter and one 330-k.v.a., 4400/-rotary voltage, 3-phase, outdoor type, O. I. S. C. transformer, complete with one 2-panel switchboard; Manhattan City & Interurban Railway Co., Manhattan, Kan., one 300-kw., 600-v., d.c., 3-phase, 60-cycle, 1200 r.p.m., self-starting rotary converter, and one 200-kw., 600-v., d.c., single-phase, 60-cycle, 1200 r.p.m., self-starting rotary converter, 3 110-k.v.a., 33,000-v., single-phase, 60-cycle, O. I. S. C. transformers; 3 75-k.v.a., 33,000-v., single-phase, 60-cycle, O. I. S. C. transformers; 2 2-panel switchboards; also one outdoor type transformer substation, consisting of a steel tower on which will be mounted 3 37½-k.v.a., 33,000/-220-v., single-phase, 60-cycle, O. I. S. C. transformers.

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Trade-mark reg. U. S. Pat. Office.
SEMI-MONTHLY
PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

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537 S. Dearborn Street
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POSITION WANTED—As Manager or Superintendent of an electric light or ice plant. I am a practical engineer and know the electric light and ice business thoroughly. As to my character and ability, I can furnish you all the references you wish. I am at the present employed as chief engineer of an Electric Light and Ice plant. Address B. E. C., 2004 Alston Ave., Ft. Worth, Tex. 7-1-2

POSITION WANTED—As an Assistant Engineer or an oiler. In or near Chicago. I have 6 yrs. practical experience in handling pumps or boilers; also 3 yrs. experience in steam fitting and all kind of repair work. At present I am in a 500-H. P. plant as an assistant. I have a city water tender license. I am married, age 25 yrs. Would prefer a place where I could advance myself. Address Joseph P. Sepp, 3418 Le Moyne St., Chicago, Phone, Belmont 5378. 7-1-2

POSITION WANTED—Young married man with technical education. Mechanical draftsman. Practical experience with oil engines and ice machinery. At present engineer in small ice plant. Desire position after November 1st. Best of references. Permanent position wanted with offer of promotion for the man who makes good. J. B. Walker, Savannah, Tenn. 7-1-2

POSITION WANTED—As Electrical Engineer; at present in charge of large electrical plant in New York. 12 years technical and practical experience. Strictly sober and industrious. Address William MacInally, Pleasantville, N. Y. 7-1-2

POSITION WANTED—As Engineer in small plant, or assistant in a large plant, by man of 28 yrs. No bad habits, 3 yrs. machinist experience; understands A. & D. current; holds local engineer's license. C. H. Freeman, 57 North St., Elgin, Ill. 7-1-2

Wanted

MANUFACTURERS REPRESENTATIVE, favorably known and of wide experience in modern engineering, wishes to handle power-plant equipment, engines, boilers, stokers, etc., in Pittsburgh district. Daniel Ashworth, M. E., 1225 Fulton Bldg., Pittsburgh, Penn. 7-15-1

AMERICAN SERVICE CO., Pittsburgh, Pa., require records of engineers, superintendents and production clerks for executive and shop vacancies. 7-15-1

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—One 350- to 400-hp. high-pressure boiler. Address Wausau Box & Lumber Co., Wausau, Wis. 7-1-2

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in the state of Washington. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

FOR SALE—One 10″x16″ Ideal tandem compound center crank steam engine, 100 i.h.p. at 270 r.p.m. High pressure cylinder has piston valve, low pressure cylinder, balanced slide valve, operated from inertia type shaft governor. Fly wheel 5′ 8″, 15″ face. Steam pipe 4″, Exhaust 5″, shaft, 5½″, over-all dimensions 5′x11′ 7″.

One 10″x9″ simple Junior Westinghouse engine; capacity 50 i.h.p. at 335 r.p.m.; fly-wheel 3′ 6″ diameter, no belt wheel; steam pipe 3½″, exhaust 4″, shaft 3⅜″; over-all dimensions 3′ 8″x7′ 2″. For further information concerning these engines address James M. White, Supervising Architect, University of Illinois, Urbana, Ill. 6-15-3

FOR SALE—One 30 to 40 H. P. Elyria "Little Big" Gas Engine. In service only about one year. In first class condition and practically as good as new. Dudlo Mfg. Co., Ft. Wayne, Ind. 7-15-1

FOR SALE—Cost Sheet, giving cost of fuel for oil, gas and steam engines and current for electric motors; at all prices and rates of consumption; folding pocket size, 10c, stamps or coin. A. Stritmatter, 213 E. 7th, Cincinnati. 7-1-2

FOR SALE—One Bristol Recording thermometer with 25 ft. of flexible tubing. One Edwards Pyrometer, 0 to 1200 degrees. One calorimeter complete with nozzles in polished case. Write to-day. Taylor, 85 S. Monroe St., Battle Creek, Mich. 6-15-3

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THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G St. Washington, D. C. 7-1-2

PATENTS SECURED—Send sketch or model for search. Book containing over 200 mechanical movements, advice and search free. W. N. Roach, Jr., 515 Metzerott Building, Washington, D. C. 5-15-7

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owens Bldg., Washington, D. C.

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ELECTRICITY—JUST WHAT YOU HAVE been looking for. Our Modern Blue Print Chart Method of Electrical Wiring Diagrams. Thoroughly explained so that you can easily understand them. All kinds of Bell Wiring, Annunciators, Telephones, House Wiring, Conduit, Theatre, Isolated Plants, Dynamos, Transformers, Arc Lights, Special Treatise on Motor Wiring. Write now for information. Electrical Wiring Diagram Co., Box F. 173, Altoona, Pa. 6-1-6

ENGINEERS' POCKET MANUAL. 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gild edges, bound in leather.

Miscellaneous

IF YOU ARE an operating engineer, we know the Fetta Hot Process Water Purifier will interest you. We would be glad to have your request for further information. Address the Fetta Water Softener Co., Richmond, Ind. tf.

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

The engine in a Chicago man's automobile stopped last Sunday, when he was about 40 miles from home. He *tinkered* with the carburetor, *fussed* with the spark plug and magneto, *crawled* under the machine a few times, and, finally, *hailed* another autoist and was towed back to town. He told his troubles to the young man at the garage, whereupon that individual casually walked over to the machine, and after a minute's inspection said, "You're out of gasoline."

This man had spent hours which *correct knowledge* would have shortened to a few minutes. He had wasted *Time,* the most valuable element in the Universe.

Stop and ponder.....!

A man rushing across country in a special train to a dying member of his family offered the engineer one hundred dollars for *every minute* he gained on the schedule.

A delay of twelve hours in the delivery of a letter to Grouchy, enabled Blucher and the Prussian troops to join Wellington, caused the defeat of Napoleon, overthrew an empire, and changed the map of Europe.

A nation spends years and millions in dividing a continent to gain a *shorter* passage from East to West.

Yes! Time is at once the most valuable and most wasted element in Man's Life.

It has three divisions: *Rest, Play, Labor.*

Labor is apportioned two-fifths of the hours. And, the *degree of accomplishment* is gauged by the *economizing* of them.

All of us are familiar with the man who fusses, fumes and frets away the hours on little jobs. We are acquainted also with his co-worker who, without ostentation or confusion, accomplishes the same results in a few minutes.

The latter wastes no effort. He knows; *Knowledge* is always a *conservator* of *Time.*

The engineer who can *conquer* an emergency, *on the spot,* is undeniably of higher worth than the one who must use reference books, consultations and outside help.

You can stay in your plant from sun-up until midnight and work the flesh off your bones, but this extra effort will not *create* the favorable impression with the "old man" that a day's work of *even hours* and *regular completion* will do.

Shove the *most accomplishment* into a minute and you will succeed. To do this you need the aid of *Knowledge.*

You can get the address of *Knowledge* through *Study.*

Study the advertisements in Practical Engineer. Search through this *market place* of the Power Plant Men. You'll learn time-saving facts.

For illustration, suppose that in the middle of the *busy day,* when the machines are throbbing and pulsing with the life from your power plant, the main steam valve should blow out.

Shut down the plant.....!

Get another valve—*any make*—right away .....!

From what point can you get it with the least delay.....?

Right there is where a mental inventory, gained through continuous reading of the Advertising Pages of Practical Engineer, would save valuable time.